THE

SECOND REPORT

OF

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TO THE

HOUSE OF DELEGATES

OF

MARYLAND.

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REPORT.

The State Agricultural Chemist has the honor to submit to the House of Delegates of Maryland, the following REPORT:

A very brief and imperfect history of Agriculture will show what progress it has made, and what have been its means of improvement. From its present condition we may judge whether these same means are sufficient, or whether other resources should not be obtained for, and new principles be applied to it. If Agriculture at present is as perfect as from its nature it can be, then let us only follow in the paths of those who have preceded us; if it be capable of improvement, we should at once adopt means to effect that improvement.

Agriculture as an art has had the benefit of the recorded teachings of experience for three thousand years, and yet is far, very far, below perfection. Nay, more, it is but little more perfect now than at the Christian era, and its improvements are almost exclusively of a mechanical nature, owing their existence to the application of science to mechanics.

If, with empirical experience in such a length of time, it has made such little progress, should it not now invoke the aid of science, and especially of that science which, to a great extent, has contributed to perfect every art that has sought its assistance?

The literature or description of any art is generally in proportion to the degree of excellence to which that art has attained. Judging ancient and modern Agriculture by this rule, the preference is greatly due to that of ancient times, not only for beauty of description, but also for accuracy and connection in details. However beautifully and poetically Virgil may have written, his descriptions of the different modes of husbandry, and his advice as to cultivation, all bear the marks of practical knowledge, and many of them are better as general rules than some which are followed at the present day. His recommendation to burn grass, stubble and weeds on land, is good practice in many places at the present

time in Maryland. "Filix urenda crepitantibus flammis," is as accurate in practice as it is beautiful in description. In recommendations for the preservation and collection of manures, at the beginning of the Christian era, as precise and good practical advice was given as that which is recommended at the present day, viz: to collect weeds, earth from the woods, &c., for compost heaps, to cover over manure heaps with dirt, that nothing be lost, and that in giving abundance of food to stock we obtain some compensation in the increased value of the manure,—a fact proven by the most careful scientific experiments of modern times. To change the mechanical texture of lands, the practice was followed which is good at the present day, to mix the light with stiff, clayey with sandy soils, and vice versa. In the details of husbandry good practical principles were urged, economy is always advised, expensive outlays are always reprobated, and an unanimous verdict is given against what is now called "farming on the high pressure principle." The greater profits of small than of large farms was insisted on, and the advice given to purchase a small though we might praise a large farm. The advice given by Cato s so correct that I need no apology for inserting it here:

"When the proprietor arrives at the villa, and has paid his respects to the household gods, he should, if he possibly can, go round his farm on that day; if he cannot do that, certainly on the next. When he has completed his own inspection, on the morrow he should have up his bailiff, and inquire of him what work has been done, and what remains to be done—whether the work is sufficiently forward, and whether what remains can be got through in due season—what has been done about the wine, corn, and all other matters. When he has made himself acquainted with these things, he should then compare the work done with the number of days. If work enough does not seem to have been done, the bailiff will say that he has been very diligent—that the slaves could not do any more—that the weather has been bad—that slaves skulked—that they have been taken off to public work. When the bailiff has given these and many other reasons, bring him back to the actual details of work done. If he reports rainy weather, ascertain for how many days it lasted, and inquire what they were all about during the rain. Casks might be washed and pitched, the farm-house cleaned, corn turned, the cattle-sheds cleaned out, and a dung-heap made, seed dressed, old ropes mended, and new ones made; the family might mend their cloaks and hoods. On public holidays old ditches might have been scoured, the highway repaired, briers cut, the garden dug, twigs kidded, the meadow cleared, thistles pulled, grain (far) pounded, and every thing made tidy. When the slaves have been sick they ought not to have had so much food. When these matters are pretty well cleared up, let him take effectual care that

the work which remains to be done shall be done. Then he should go into the money account, the corn account; examine what has been bought in the way of food. Next he should see what wine and oil have come into store, and what have been consumed, what is left, and how much can be sold. If a good account can be given of these things, let it be taken as settled. All other articles should be looked into, that if any thing is wanting for the year's consumption, it may be bought; if there is any surplus it may be sold; and that any matters which want arrangement may be arranged. He should give orders about any work to be done, and leave them in writing. He should look over his cattle with a view to a sale. He should sell any spare wine, oil, and corn, if the price suits. He should sell old work oxen, and culls, both cattle and sheep; wool and hides, old carts and old iron implements; *any old and diseased slave;* and any thing else which he can spare. A proprietor should be seeking to sell rather than to buy."

The above advice, given on the banks of the Tiber, near 2000 years ago, could at present be judiciously followed on the banks of the Patuxent or Potomac.

The names of the prominent Agricultural writers of ancient times have no rivals amongst the moderns up to the beginning of the present century—we may look, and look in vain, for their equals. Hesiod, Theophrastus, Xenophon, Cato, Varro, Virgil, Columella, Pliny, Palladius, and Mago the Carthagenian, have no equals at the present day. These were writers not of one age nor of one country, they were men scattered through a series of years, some being Greeks, some Romans, others of the barbarous nations.

These writers, though of the highest literary skill and excellence, yet are valuable practical teachers. A writer in one of the late English reviews truthfully observes: "That we might take up almost any of the old agricultural writers, and begin with him the year—prepare the field, sow the crop, weed it, reap it, harvest it, thresh and winnow it, ascertain the weight per bushel, and the yield in flour or meal, market it; buy, feed, clothe and lodge the agricultural slaves; purchase, rear and sell the cattle and fowls; collect and prepare the manure; and make out at the end of the year a more accurate balance sheet than could be furnished by half the farmers in Great Britain."

Finally, on almost every subject that could be improved by practical experience they had attained very high skill, yet their Agriculture was not at its perfection, nor has mere practice and experiment made it any more so in our day. Its true principles not being understood in ancient times, the most correct practice could not be followed. Chemistry had not then pointed out the connection between the plant and the soil. It had not then, as

it has within the last ten years, "given to Agriculture the most complete explanations of the nutrition of plants and of the sources of their food." It had not then, as now, "shown that plants must obtain from the soil, as well as from the atmosphere, a certain number of elements, if they are to be developed and thrive on the soil."

To this, and this alone, is to be attributed the causes of its uncertainty, its conflicting theories, its defective practice. In an article published recently in one of the English reviews, to which I am under many obligations, a most interesting and lengthy history is given of the literature, state and condition of ancient Agriculture, and its excellence being considered and proven in many instances, equal to that of the present century, notwithstanding we are accustomed to view ourselves as superior in every thing to every age that has preceded us. The writer does not mention, however, that whatever our Agriculture may have been ten years ago, it has vastly improved since; more improvement having taken place within that time than in any ten previous centuries, and that improvement due to the application of the science of Chemistry to Agriculture, which will eventually, judging of the future by the past, give us a perfect system of Agriculture.

An empirical system—that is, a system founded on mere experiment—the observation of the effects of agents without being traced to their causes; without understanding the reason of their action, or the manner in which they act, cannot give improvement beyond a certain point or a certain space. It cannot be broad, general, universal and perfect; it must of necessity be narrow, contracted and defective in its application. A rational system, on the other hand, a system based on experiment, with a full knowledge of all the causes which induce its success or failure, with a thorough understanding of all the properties of different elements entering into any combination, with a knowledge of the causes of failure, and a knowledge of means to avert those causes, must in Agriculture be general and cosmical. In its essence, Truth, it will teach truth every where; it will point out error so plainly that it can never long wear the livery of truth; "Truth, that pillar of the earth, yet a cloudy pillar; that golden and narrow line which the very powers and virtues that lean upon it bend; which policy and prudence conceal; which kindness and courtesy modify; which courage overshadows with his shield, imagination covers with her wings, and charity dims with her tears."

Lord Bacon observes that those systems which are based on truth and knowledge always increase, whilst those grounded on speculation increase not, and history has shown this to be the case universally. How important, then, is it to apply to an art—the most important of all arts—knowledge, instead of suffering it to run in wild speculation and error. A knowledge of history has shown

that the art of Agriculture, unaided by science, made but little if any progress in a thousand years, and we know that in the last ten its most important improvements have been made. We have seen that experience without science has not improved the art, because no principle could be established of general application. A manure beneficial in one place was found worthless in another; because no rule could be give for its use, no reason for its failure. The success of one might thus bring loss to another who might be induced to follow in his paths—and why? because empiricism can give facts, not reasons—local maxims, not general laws.

Where many facts are known and where they must be constantly accumulating as in agriculture, science is especially required to arrange those facts, show the reasons of their occurrence, and from its deductions give general, universal laws. Since the repeal of the corn-laws under Sir Robert Peel's administration, owing to the application of chemical science, the increased crops in some parts of England have counterbalanced the duty which was on bread stuffs. "Moreover," says an able writer in the North British Review, "just in proportion as in any part of Britain agricultural science has improved, in the same proportion has practical agriculture. It is at least a curious coincidence that Scotland, which justly boasts of the best practical farmers and gardeners, should also boast of the best agricultural chemists." We have seen how important science, especially chemical science, has been to every art. I could fill pages with examples, but your honorable body knows them already. Indeed I cannot see how any Agriculturist, unless blessed with knowledge far above that of the world, can fail to be benefited by that science which can determine the nature and quality of the elements of the soil with almost infallible exactness; determine in like manner the composition of manures, and thus adapt the one to the other without loss and without disappointment. Chemistry has determined the constituents of plants, and thereby made known the substance necessary to their existence. It can teach the composition of fertile soils and thus show practically how those which are barren can be made equal to them. It detects the composition of different manures, too often thrust upon the farmer with imposing certificates, and sometimes worthless. When aided by a sufficient number of practical observations, it will make farming as certain as any thing which has to depend on atmospheric influence for success. Let it not be supposed that I undervalue Agriculture as an Art; it is both an art and a science. Mere science cannot be a substitute for practice, judgment, and manual dexterity, and we have seen that those unaided by science have failed to give us a perfect system, nay, more, have ceased to approximate to it. They must be joined together, each giving the other support, each giving and receiving benefit in an equal degree; practice and

experiment affording the materials, science arranging and building up a perfect system. They too will serve as a check upon each other. The present age is progressive and revolutionary, and in its yearnings after progress sometimes may overstep the bounds of prudence. It needs judicious conservatism to check the attraction of novel theories and correct the influence of fanciful abstractions. Maryland, more than any other State, should apply the aids of science to her Agriculture, her geographical position in its natural advantages gives her the facilities of market possessed by none of her sister States, her climate is most propitious to the cultivation of all the necessaries and luxuries of life. The cost of means to improve her soil will be less than elsewhere, because neither they, nor the crops which they produce, can be taxed with expensive carriage. She has granted millions to open a communication with the fertile virgin soils of the great West, which will pour its productions into markets in competition with her own, a competition which she can successfully resist only by improving her soils and protecting her agriculture. Without this she has every thing to fear from competition; with it, nothing.

In accordance with the manner which I have proposed to myself as best suited to carry out the purposes of the law under which I have the honor to act, I shall present to the citizens of Maryland, in as brief and concise, and at the same time as clear a manner as possible, 1st. The true philosophical principles of Agriculture, with a short description of the elementary bodies, or their combinations found in plants. 2d. a brief history of the manures in general use, whether foreign or domestic, with precise directions for their preparation and application; under this head I shall state whatever facts in relation to them as in my judgment will best subserve the interests of the Agricultural community. 3d. I shall show as far as possible the proper application of these manures to that portion of the State visited since my last report to your honorable body.

All vegetable substances depend for their production upon certain substances either furnished to them from the air or from the soil upon which they grow. Upon an examination of any or all of the products of the earth, there are invariably found two kinds of bodies sufficiently distinct in their general and special properties to be arranged under two separate and distinct classes, the one of these is called Organic, the other Inorganic; the former having its form easily and rapidly changed by heat, or by the slow process of decomposition, the latter being more fixed and not susceptible of change by causes which entirely destroy the combinations of the former. Let a piece of wood or straw, grains of wheat, or any vegetable substance be exposed to a red heat, with free access of air, and we find, after a certain time, that their forms are changed, their bulk very much diminished, and a

large proportion of their weight dissipated, there being left behind only a small quantity of what are commonly called ashes. These are the inorganic, or mineral, whilst that part which has disappeared are the organic constituents of vegetable structure.

The part which has disappeared in the air is that portion of plants which was almost entirely obtained from it during their growth, the part remaining and called the ashes, the inorganic or mineral part, is that portion furnished entirely by the soil, because it does not and cannot exist in the air.

The part which is dissipated by heat, called organic or vegetable matter, forms by far the largest proportion of the weight and bulk of all vegetable and animal structures, composing generally from ninety to ninety-eight per cent. of their weight. But although the elements of organic matter form so large a proportion of the weight of all living bodies, yet they are not more essential to their existence than the inorganic or mineral portion. The elements or constituent parts of organic matter are carbon, oxygen, hydrogen, and nitrogen, which by their combinations with each other form, as I have said before, by far the largest part of the weight of all living bodies. These elements moreover constitute the water which is found in the earth, the matter of the atmosphere which we breathe, and also in combination with mineral matter a very large proportion of the solid part of the earth. Bodies existing so abundantly, so widely disseminated throughout the universe, are most important subjects for consideration and for attentive study. Their properties, nature, and uses should be well known by all who, in their occupation in life, strive to lift their minds above the earth and follow their callings with intelligence as well as mere brute strength.

CARBON.

Of all the components of vegetable life, carbon is the most abundant. In its pure state it exists as a solid, differing in this respect from the other three, which naturally exist in an aeriform or gaseous state. It is the essential principle of the different varieties of charcoal. It is abundantly formed by burning wood, with but slight access of air, and can also be produced in a very pure form from sugar, turpentine, starch and vinegar. The mineral called graphite or blacklead is almost pure carbon, and in the diamond it is perfectly pure and also crystalized. When united in certain proportions to oxygen, it then loses its solid, assumes the gaseous form, and performs a most important part in the process of vegetation. The compound thus formed is called carbonic acid, it extinguishes burning bodies, and even in moderate proportion is fatal to *animal* life. Where combustion does not take place from the presence of carbonic acid, animal life cannot exist. It is the presence of this gas which

causes the impurity of air in wells, and hence the custom of letting down a lighted candle before persons will venture to descend. If the candle goes out, the air is certainly impure, and persons cannot encounter it with safety; and even when it exists in quantities not sufficient to put out the candle, yet enough may be present to produce serious, and even fatal effects to those who encounter it. Although when breathed it proves so noxious, yet when taken into the system by other means its effects are quite agreeable. It is this which gives to the different artificial mineral waters their pungency, and to beer, porter and some kinds of wine their pleasant flavor, which being lost by exposure to the air, renders them stale, tasteless and flat. Water absorbs it readily, and thereby acquires the ability of dissolving the mineral or inorganic constituents of soils; a most important property, as we shall hereafter see. It is always exhaled from the lungs of animals during respiration. This gas is formed by the burning of wood and coal; it is emitted from volcanoes, and is also a constant product of the decay of vegetable and animal matter; and therefore always exists in the atmosphere.

Since its sources are so constant and so abundant, the inquiry naturally presents itself, how is it that it does not accumulate in sufficient quantities to render the air unfit for the purposes of breath. Here the science of chemistry unfolds at once the beneficence and wisdom of the Creator in a most striking and wonderful manner. This wisdom and goodness is moreover manifested by means so perfect, and withal so simple as to call forth our highest admiration of, and our greatest adoration and gratitude to Him who employs them for our good.

"Whenever it is vouchsafed to the feeble senses of man to cast a glace into the depths of creation, he is compelled to acknowledge the greatness and wisdom of the Creator of the world. The greatest miracle which he is capable of comprehending is that of the infinite simplicity of the means, by the co-operation of which order is preserved in the universe, as well as in organism, and the life and continued existence of organized beings secured."

The causes which I have enumerated would, if not counteracted, soon render the earth unfit for animal life; but that which animals throw off as unfit any longer for their use, is that without which vegetable life could not exist. That which is poison to the one is food to the other. For all vegetables absorb through their leaves this, to animals deadly poison, and separate the carbon so as with it to build up their structure; while they exhale the other constituent, oxygen, to purify the air. There is thus ever kept up a healthy balance in the atmosphere; and a constant and necessary relation exists between vegetable and animal life. Where the one exists in the greatest abundance, the other will also ever be found

in like ratio, and animals depend for their food on vegetable production no more than vegetables on animals for the materials for their structure. Every tree, plant and shrub that grows purifies the atmosphere, and furnishes air for the use of man and the inferior animals; every thing that breathes the air, from man, the lord of the creation, to the veriest reptile, is a purveyor of food for vegetable subsistence. Wherever, therefore, animals abound, carbonic acid is largely formed; but this carbonic acid, in giving its carbon to vegetables, gives also its oxygen to purify the air, and furnishes the means of breathing to men and animals. Decomposition of animals, and the decay of vegetables also, afford both carbonic acid and ammonia, the very materials for the growth of a new series of life. The death of one generation thus becomes the source of life to another, and each living generation is the phœnix arising from the ashes of that which preceded it, a life whose very existence depends upon previous death. This is a type of what revelation teaches, that we shall not "surely die;" but that death is but a means to and a necessary precursor of a glorious resurrection. There is taught too by this simple yet beautiful and perfect process, the mutual dependence which exists, not for pleasure only, but for life itself, between all the systems of animated nature, that nothing is in vain, nothing lost, each humble plant that grows may be nourished by the breath of the greatest of mankind, and in its turn purify the air for the life of a hero. The frailest flower, though perchance "born to blush unseen," does not "waste its fragrance on the desert air." The perfume of flowers is a compound of carbonic acid and ammonia, and may be taken up by corn, wheat, or any other plant used as food by man.

The mode in which the various changes are effected deserve a passing notice. In the process of germination oxygen is absorbed, heat is developed, and probably acetic acid is formed, whose use is to extract from the soil bases useful for the further progress of the plants. The substance of the seed (starch and albumen) become soluble, and undergoes certain changes by which the woody fibre required for the stem and leaves is produced. The plant now must absorb from the air and soil matter necessary for its growth. By means of its roots the necessary mineral matter is taken up, and also ammonia and some portions of its carbonic acid. By far the greater portion of the latter is, however, absorbed by numerous pores on the bottom of the leaf, and under the influence of light, carbon necessary for its woody fibre, gum, &c., is separated and retained; whilst oxygen, fit for the respiration of animals is thrown out by pores on the top of the leaf. During daylight plants are continually absorbing carbonic acid and giving out oxygen; in the night the contrary, to some extent, prevails; they then throw out carbonic acid. This ex-

plains partially the fact of the greater and more rapid growth of vegetable life during the summer season, when the days—the period of light in which the plants assimilate carbon and build up their structure—are much longer than in other seasons of the year.

OXYGEN.

Another of the elementary constituents of organic matter is oxygen, and one of the most generally diffused in nature, though contrary to what some have said, it performs no more important part than any of the other elements. All are necessary; each performing its special part assigned to it; they are all links in the great chain of matter—all parts of

> " One superior Whole,
> Whose body nature is, and God the soul."

It forms a large part of the atmosphere which surrounds the earth, about eight-ninths of all the water in existence, besides forming a very large proportion of rocks, minerals and soils. In water it is in chemical union with hydrogen, and in the air it is only mechanically mixed, not chemically combined with nitrogen, both elements of organic matter hereafter to be described; but in soils and rocks it is combined with various bodies, affecting their properties in a very great degree. In its pure state it is invisible, colorless, tasteless, and without smell. It has a very strong affinity for almost all bodies, and the compounds thus formed are called either Acids or Oxides. The *act* of combining with oxygen is called *oxidation*, the former of these possesses the general properties of acids; the latter of bases, which by uniting with the former produce salts;* thus sulphur and oxygen in certain proportions form sulphuric acid or oil of vitriol. Calcium and oxygen in certain proportions form lime, a base which when united to the sulphuric acid produces a salt (sulphate of lime or gypsum.) The phenomena attending oxidation are very variable. Ordinary combustion is only oxidation taking place in a rapid manner; then again it takes place slowly without any manifest development of effects, as when iron, zinc, or copper rusts. The burning of wood and the rusting of iron are both examples of oxidation; in the one case occurring more rapidly than in the other, and in each oxygen is obtained from the air. Another instance of slow oxidation is the gradual decay, or slow combustion, (Eremacausis, as it has been termed by Baron Liebig,) of organic matter when exposed to the air. By it all organized bodies are resolved into forms capable of being used as food for plants. It is this gas which when breathed supports animal life, and almost all changes in animate or inanimate nature take place in consequence of its increase or diminution.

*Hydrogen is also essential to give sulpur acid properties.

HYDROGEN.

This is also one of the four organic elements. Like oxygen, it is very extensively diffused throughout all nature; like it, it is a gas invisible, tasteless and inodorous. It is the lightest body in nature, and hence used for filling balloons. It is never found isolated, but always in union with some other body. With oxygen it forms water, and with carbon the gas so generally used for light. It is very combustible, and when burned by means of the hydro-oxygen blowpipe, (an invention of the celebrated Dr. Hare, of Philadelphia,) produces the most intense heat yet known.

NITROGEN,

Like hydrogen and oxygen, when uncombined, always exists in the gaseous state, and like them it is tasteless, colorless and without smell. It forms about four-fifths of the atmosphere, a small proportion of vegetable and a large share of animal matter. It has in its pure state no very sensible and direct properties, and is better known by those which are negative. It does not support combustion, but extinguishes all burning bodies that are surrounded by it alone, and no animal can live in it when puie, though it has no deleterious properties; combustible matter refuses to burn, and the animal dies because deprived of oxygen or vital air. It serves as a diluent to moderate the action of the oxygen in the air which we breathe, for no animal can live but a short time in this latter gas; and if nitrogen was not present in the air, in a short time not only would trees and forests, but also iron itself, be burned in one general conflagration. When combined with hydrogen this substance forms ammonia, so necessary to the formation of vegetable and animal life, and that which constitutes the chief valuable constituent in Peruvian guano. This substance, a product of the decomposition of organic matter, always exists in small quantities in the air, whence it is brought down by dew, rain and snow to the earth, where it is retained for the use of the plant. Although nitrogen exists so abundantly in the air, and forms so large a portion of plants, yet they cannot use it in its pure form; it must be supplied to them in the form of ammonia, or of nitric acid, as some say. Their leaves imbibe and exhale, but use it not. The experiments to support the contrary idea are inconclusive, as all their results can be explained without coming to the conclusion that nitrogen, as such, is supplied directly to plants from the air.

I have now given the most marked properties of the four elementary organic substances which form the air we breathe, the waters of the earth, a large part of the earth itself, and of the animal and vegetable tribes which inhabit it. Their names and

properties may not be familiar to some; very many may be entirely ignorant of them; but what can be more appropriate subjects for study and investigation than the air which supports our lives from its first moments, the water which is to us daily food, or the composition of that food, which by the curse of labor we are obliged to earn—a curse, however, changed by mercy into a blessing, when the intellect is used to lighten the toil of the body. Is a knowledge of these substances useless? then the knowledge of those things nearest to us, and with which we hold constant relation, is useless; and if these are, those which are more remote must of consequence be more so, and all knowledge is vain; and if knowledge be nothing, then men are on a level with brutes—nay, below them. The most noted properties of these substances can be easily understood and as easily learned as the multiplication table, and will enable the tiller of the ground to understand many facts of great use to him which are now incomprehensible, and give him, as the fruits of labor, pleasure as well as profit.

The substances which I have mentioned above, namely, carbon, oxygen, hydrogen and nitrogen, are combined with each other, and form many substances, of which it is not my province here to speak. I will mention some whose constitution it is proper to know.

Carbon and oxygen form carbonic acid, whose uses and properties I have spoken of above. Hydrogen and oxygen form water, which serves either as such, or by its elements, to produce a large part of the mass of vegetable matter; it moreover is the vehicle for the transportation of food to the plant, and causes matter by dissolving it, to assume a form, giving to it the properties of food.

Hydrogen and nitrogen, form ammonia, of which I shall speak particularly, when I come to speak of guano. All these are formed by chemical combination in which the original elements lose their characteristics, and, indeed, assume others sometimes the reverse of any which previously existed. Thus carbon, a hard solid, and oxygen, a gas, form a gas. Hydrogen and oxygen, two invisible gases, form water. The air is, as I have before stated, composed of nitrogen and oxygen in the proportion of very nearly four parts of the former to one of the latter; not in chemical combination but as a mere mechanical mixture. Besides these, the air also contains watery vapor, carbonic acid, and ammonia, the latter two in small quantities relatively, but still in immense quantities absolutely, and of vast importance. Though the above substances are of such vast consequence in vegetable life, and form nearly all of the woody fibre, leaves, stem, juices, gum, sugar, starch, acid, gluten, and albumen, (the last two being the nutritive principle in wheat, corn, &c.,) yet they are of no

more use than certain other substances forming part of a class called inorganic bodies, which are of equal necessity to the animal, and are always ever present in productive soils, and in a form, state, or condition capable of being taken up by the plant. These essential elements are—

Phosphorus, Sulphur, Chlorine, Silicon, Calcium, Potassium, Sodium, Magnesium, Iron and Aluminum.

These do not exist in either animal or vegetable matter, or in soils in their pure state. Thus phosphorus is united to oxygen and becomes phosphoric acid, and then in the soil is *almost invariably* found united to iron or alumina, making a phosphate of iron or alumina, as the case may be. In plants and animals it is united to lime and magnesia forming phosphate of lime or magnesia.

Sulphur is also united in soils to oxygen, forming sulphuric acid, which united to lime forms sulphate of lime or gypsum.

Chlorine in an uncombined state does not naturally exist; when pure it is a gas, which, when inhaled, even though much diluted with air, speedily produces suffocation. It is of a yellowish green color, of an astringent taste and disagreeable smell. It speedily removes all animal and vegetable colors by its bleaching powers, and when the colors are once destroyed they cannot again be restored. It is likewise a powerful agent in destroying the contagious principle of diseases. It exists abundantly in sea-water united to sodium, forming a chloride of sodium or common salt: the bodies formed by union with chlorine are called chlorides.

Silicon united to oxygen forms silica, silex, quartz, or common flint, which constitutes, in union with lime, magnesia, potash and soda, so large a proportion of the earth.

Calcium is the metallic base of lime, which, when united to oxygen forms lime, (unslaked, or caustic lime,) this on being united to carbonic acid becomes carbonate of lime or air-slacked lime.

Potassium is a metallic base, which, when united to oxygen, becomes potash; this in union with silicic acid, or flint, becomes silicate of potash, and gives to straw and the grasses their hardness.

Sodium is also a metallic base, which, when united to oxygen, becomes soda, which in union with carbonic acid is the common soda of the shops, and with chlorine constitutes common salt.

Magnesium is a metallic base, which, when united to oxygen, becomes common calcined magnesia, and exists in combination in many limestones with carbonic acid, forming carbonate of magnesia.

Iron is a metal too well known to need any description, it very rarely is found in a state of purity in soils, but exists as an oxide or rust.

Aluminum is a metallic base, which, united to oxygen, forms alumina or pure clay. Alumina is rarely found in animal, and in very sparse quantities in vegetable bodies. In different combinations it forms a large part of soils, and there exercises most important functions.

Although the ten last named elements form but a very small per centage of living bodies, yet they are absolutely essential to their existence; for without phosphate of lime and magnesia, which is a compound of phosphorus, calcium and oxygen, neither the bones of animals nor the seeds of grass nor of grains would be formed. Without sulphur no nutritive food capable of yielding blood or brain matter could be produced. Without silicate of potash and soda no stem of wheat, no blade of grass nor stalk of corn could exist. Not the most abundant supply of all the four organic elements first mentioned, which exist in the air, could produce the smallest plant or the veriest insect that crawls, unless they were in union with the other bodies last named, which are derived from the soil. Thus then the soil furnishes a material class of bodies which cannot exist in the air, necessary to the animal and necessary to the plant, and with which we must supply the soil, if they be absent, before vegetable life can be produced. In my former report I gave a table showing that all of the mineral constituents named above were necessary; that the absence or deficiency of one could not be compensated for by an excess of the others. Thus—no amount of lime would compensate for the absence of magnesia; no abundance of chlorine be a substitute for sulphuric acid; no quantity of sulphuric acid could counterbalance a deficiency of phosphoric acid or phosphates. Let those who deny this doctrine and say that all these constituents are not necessary, show a single grain of wheat, a single blade of grass, or any soil capable of producing either, which does not contain them. But not only this, a part of the substances existing in the air, are first taken in by the soil and then furnished to the plant—the soil being a medium, a kind of stomach for the proper digestion of the food obtained from the air, so that it may be used by the plant. This digestive power, or ability to produce nutritive matter, such as ammonia, from crude substances, (hydrogen and nitrogen,) depends partly on texture, partly on chemical constitution. Ammonia, as I have before said, is a compound of hydrogen and nitrogen, which is supplied abundantly to crops by the air, provided the soil has the capacity of absorbing it or of forming it from its elements; but many soils have not this power, and it then must be supplied from other sources, such as Peruvian guano, stable manure, &c. So then the capacity of production in soils depends upon the presence in them of the last ten substances named, and upon their ability to form ammonia from its elements, to absorb and retain it when already formed, and to absorb and

retain watery vapor—products of the four first named. This power of absorption is due partly to their chemical, partly to their mechanical nature. We must look to their chemical constitution to determine the presence, absence, or deficiency of those first named, to their mechanical texture, to the fineness of the several particles which make up the mass of soils, to determine their absorbent quality. The substances which have been named include all that are essential to the composition of a soil, and they are also of equal value to the organization of vegetable matter. One of them, alumina, is found in such small proportions in plants that its presence is deemed of no special value. Its duty in soils is to absorb and retain atmospheric supplies of food.

The organic elements form, by different modes of combination, a very large number of substances peculiar to different plants, which substances make a difference between different classes. Thus we have gum, sugar, starch, a great number of oils, such as peppermint, turpentine, &c., a great variety of perfumes, and an almost endless variety of substances used in medicine, such as quinine, strychnine, &c., all composed of organic elements. A great many substances have been discovered amongst organic bodies composed of the same elements, and yet exhibiting physical and chemical properties essentially distinct from each other. A great class of bodies known as the volatile oils, oil of turpentine, essence of lemons, oil of balsam of copaiva, oil of rosemary, oil of juniper, and many others, differing widely from each other in their odor, in their medicinal effects, in their boiling point, contain the same elements, carbon and hydrogen, in the same proportion. No one of them contains more of either element than the others do. Nature, in her perfect laboratory, furnishing all these by skillful arrangement and mode of union; now making food to support life; now a deadly poison to destroy it; now a sweet perfume; now a most fetid odor; now a brilliant dye. We have the same elements partially under our control, and though we cannot vie with her in formative skill, yet we can, by calling the intellect to aid the labor of the hands, make the earth to yield its fruits abundantly, secure a sustenance for ourselves and a heritage for our posterity.

I propose now to give the composition of one of the crops most usually cultivated for food, as to its mineral constituents, being those which come from the soil and which cannot be furnished by the air, thereby to show the connection which exists between the soil and plants. We might go further and from an inquiry into the material of animals show a threefold connection, a system of mutual dependency, but this is not pertinent to our subject.

In the soil we find the mineral or fixed constituents to exceed the organic or those which are not fixed. In the plant, the or-

ganic always greatly exceeds the mineral matter. As I have before frequently said, though the mineral matter be so small in proportion to the organic, it is not on that account of less importance; and though the quantity be small in reference to the organic matter, yet when we consider the quantity removed by a crop when exported from an acre, it assumes a high degree of importance. The analysis of 62 specimens of wheat gives, on an average, 1.67 per cent. of mineral matter. A bushel of *wheat*, weighing 61 pounds, will remove on the average exactly one pound of mineral matter. Twenty bushels will remove twenty pounds; a yield of forty acres carries away 800 pounds (every time that it is in cultivation) of substances vitally necessary to the growth of wheat, and which can in no way be replaced save by manure containing the elements carried off, or by the slow degradation* of the soil: but the soil sometimes has not the substance needed in sufficient abundance to supply the crop. Manures, then, must be looked to; but what manures? not those of which the soil has the materials already, but those which it has not; or which if it has, not in sufficient quantity for the use of the plant. Here at once is a peremptory necessity for analysis; here at once is a peremptory necessity for knowledge and certainty, instead of ignorance and speculation.

But to return. At every rotation of a forty acre field, 800 pounds of food is removed from the storehouse of the wheat plant; in twenty years, with a four year rotation, there departs 4,000 pounds. Does not this explain facts of which unfortunately your honorable body and the State at large are too familiar? These facts are the deterioration in the value of lands, the loss to the state from deficient production of crops, and the far greater loss in the services of the best and most industrious of her working population, her honor, her defence, her pride, who are obliged to leave their homes, and seek elsewhere that support which the soil of their childhood denies to them.

Does not this explain how for the first few years of a virgin soil fine crops are produced, these become so small at last as not to remunerate for their cultivation; a crop requiring less strength in the land is next substituted, and so on, until scarcely any crop at all will be produced. When those soils are to be improved, shall their owners apply manures in the dark, and walk wearily along the path of experiment, or shall they be furnished with those lights which will at once give them strength, energy and activity, because certainty and knowledge?

* In speaking of rocks, soils, &c., the term *degradation* means the breaking of them up into smaller particles, by which they assume a form which renders them more easily soluble. This is effected by various agencies, alternate freezing and thawing, cultivation, application of lime, &c.

Composition of the Ash of twenty-six different Specimens of the Grain of Wheat.

No. of Specimen.	Variety.	Soil.	Ash per Cent.	Silica.	Phosph. Acid.	Sulph. Acid.	Carb. Acid.	Lime.	Magnesia.	Perox. Iron.	Potash.	Soda.	Chloride of Sodium.
2	Hopeton..........	Stonebrash................	1.81	2.84	47.00	0.24	0.23	3.20	12.71	0.60	33.15		
10	Ditto...........	Calcareous brash and clay,.	1.51	1.41	46.18	0.48		2.82	13.99	0.00	33.00	2.07	
11	Spalding..........	Calcareous................	1.81	2.23	48.21	0.11	0.22	2.88	11.06	0.23	29.76	5.26	
12	Hopeton..........		1.48	5.91	41.22	1.91		4.29	13.57	1.36	27.06	4.08	0.55
26	Creeping Wheat...	Clay and sand.............	1.73	5.32	46.49	0.61		1.50	12.35	0.22	31.18	2.42	
27	Ditto..........	Ditto..................	1.65	2.55	45.64	1.55		6.76	13.06	0.11	28.89	1.40	
28	Ditto..........	Calcareous rubble.........	1.71	1.34	48.53			3.72	12.74	1.40	30.94	1.28	
29	Red-Straw White..	Loam (green-sand)........	1.70	9.71	40.91	0.08	0.16	1.45	9.53	3.34	31.00	2.54	0.34
30	Hopeton..........	Loam....................	1.56	2.28	45.73	0.32		2.06	10.94	2.04	32.24	4.06	0.27
31	Hopeton..........	Flint and chalk	1.63	4.43	45 30	0.59		1.83	12.43	1.76	29.92	6 08	0.64
34	French Wheat.....		1.55	3.05	43.47	0.35		3.47	13.94	0.97	32.39	2.32	
35	Egyptian Wheat...		1.97	4.97	41.03	0.18		4.34	11.12	1.18	36.60	0.53	
36	Odessa		1.50	4.48	45.80			3.17	14.28	0.89	30.30	1.00	
37	Marianople		1.70	4.00	34.44	0.24		2.05	14.09	trace	35.77	9.06	
38	Hopeton..........	Silicious sand.............	1.61	4.23	39.97	0.15		1.32	13.26		36.43	4.62	
39	Ditto...........	Stiff clay................	1.63	3.05	47.33			4.43	9.32	0.35	32.05	3.38	
40	Ditto...........	Sandy....................	1.71	5.63	43.98	0.21		1.80	11.69	0.29	34.51	1.87	
41	Ditto...........	Clay.....................	1.69	3.69	49.22	0.18		2.51	12.38	0.08	30.32	0.07	1.60
42	Ditto...........	Silicious sand.............	1.76	3.29	44.44			8.21	9.67	0.08	32.14	2.14	
43	Red-Straw White..	Silicious sandy loam.......	1.72	2.14	49.58	0.60		3 27	13.75	0.23	29.75	0.64	
44	Ditto..........	Ditto................	1.73	2.63	47.44			3.39	14.05	0.67	29.91	1.87	
45	Ditto..........	Calcareous (carboniferous).	1.61	2.76	47.38	0.07		6.87	11.46	0.07	30.13	1.25	
46	Ditto..........	Clay loam................	1.60	3.89	46.79			1.15	13.39	0.91	30.02	3.82	
47	Ditto..........	Calcareous and silicious sand and clay........	1.90	2.17	46.61	0.44		5.05	14.22	0.09	29.17	2.20	
48	Ditto..........	Magnesian clay...........	1.73	2.05	46.99	0.24		6.78	12.76	2.32	26.70	2.12	
50	White Wheat	Chalk....................	1.84	5.46	40.57	0.32		3.21	9.56	2 06	34.26	4.53	

There will be found in the foregoing table all of the mineral substances which I have enumerated; they will be found too in different proportions, but still ever and always present. Phosphoric acid forms about 45 per cent. of the ash; sulphuric acid about 1-3 per cent.; lime is about 1.70 per cent.; magnesia about 12 per cent. of the inorganic constituents, (a fact which I shall hereafter advert to,) and potash about 31 per cent.

Going now to the straw of wheat, we find the greatest per centage of inorganic matter to be 4.20 per cent.; departing from it to the chaff, we there find about 9½ per cent. The great amount of ash in these is dependent upon the greater amount of silica required to give strength to the straw, and firmness to the husk.

Analyses of 10 specimens of Wheat Straw and Chaff together.

Variety.	Soil.	Silica.	Phosph. Acid.	Sulph. Acid.	Carbonic Acid.	Lime.	Magnesia.	Perox. Iron.	Potash.	Soda.	Chlor. Sodium	Ash of Chaff.	Ash of Straw.
Creeping .	Clay and sand .	73.57	5.51	2 14		5 91	1.25	0.07	10 51	1.03		15 40	4.22
Ditto . .	Ditto . .	69.66	6.62	3 95		7.46	1.56	0.28	10.31	0.13		13.04	4.60
Ditto . .	Calcareous rubble	69.94	8.54	2 33		4.94	1.43	0.06	12.48	0.25		16.54	4.30
Hopeton .	Sand	69.36	5.24	4.45		6.96	1.45	0.73	11.79			11.77	4.07
Ditto . .	Silicious sand .	67.10	7.05	5 59		4.44	3 27	1.54	10.03	0.85		10.36	4.16
Red-Straw White .	Silicious sandy loam . .	70.50	5.77	3.31		3.53	3.29	0.14	12 76	0.68		13.78	4.68
Ditto . .	Calcareous brash .	71.49	3.37	2.28		7.34	3.53	1.11	9.47	1.39		7.04	2.74
Ditto . .	Clay loam . . .	68.92	3.21	2 21		5.63	1.76	0.43	15.50	2.29		9.45	4.20
Ditto . .	Calcareous clay, dolomitic .	66.13	8.85	2 23		6.82	3.62	0.54	11.76			9.63	4.95

A table showing the quantity of mineral matter removed by a ton of Straw and of Chaff, and one of Grain.

	Mineral matters in 100 parts of Straw Ash.	Mineral matters in 100 parts of Chaff Ash	In a ton of Straw.		In a ton of Chaff.		Removed from an Acre. In 28 bushels of grain, at 61 lbs. (1792 lbs.)		In 2109 lbs. of Straw & Chaff (18 cwt. 91 lbs.)	
			lbs.	oz.	lbs.	oz.	lbs.	oz.	lbs.	oz.
Silica..........	63.89	81.22	60	0	172	3	1	0.6	83	8
Phosphoric Acid.	2.75	4.31	2	8	9	2	12	13	7	3
Sulphuric Acid..	3 09		2	14			0	1.5	3	12
Lime...........	7.42	1.88	7	0	4	0	1	0.3	7	1
Magnesia.......	1.94	1.27	1	13	2	11	3	8.3	2	13
Peroxide of Iron	0.45	0.37	0	6	0	14	0	3.6	0	10
Potash.........	17.98	9.14	17	0	19	6	8	15	13	15
Soda...........	2.47	1.79	2	5	3	12	0	12.3	0	13
	99.99	99.98	93	14	212	0	28	6 6	119	11

Note.—For the above tables I am indebted to Prof. J. T. Way, Chemist to the Royal Agri'l Society, and S. H. Ogston, late assistant to Prof. Graham of University College, London. Interesting and valuable as they are, they would have been much more so to us on this side of the water, if the soils upon which they grew had been carefully analyzed.

This table shows that whilst a ton of straw and of chaff removes little more than half the quantity of phosphoric acid that the grain does, it nevertheless takes away twice as much potash. If then a field which produces straw is deficient in grain, add the phosphates, if the grains be large, with a weak straw, add potash, or lime it, that which can eliminate or extract potash from the soil, if present, should be employed.

I scarcely deem it worth the time to mention further proofs of the necessity of thorough chemical examination preliminary to the manuring of land, nor of the value of the substances enumerated by me, and given in the above table. The *universalis consensus hominum*, the general experience of mankind in every age, bears involuntary testimony to their truth, in the application of manures. Lime and substances containing lime, have been applied for centuries. Ashes have proved their general utility by the concurrence of thousands of experiments; that general utility depends on the fact that they contain all of the mineral substances necessary to crops; whilst the fertility of land, from its organic matter and the changes which it induces, were familiar to Homer, many centuries before the Christian era.

Within the last few years Baron Liebig, a master genius—one of those great, vast and comprehensive minds whose ideas become facts for mankind—reviewing the experience of those who had preceded him, and exploring with indomitable energy and skill the composition of the earth, causing its produce to speak—giving to each tree, plant and shrub a tongue to utter words of eternal truth—to disclose their composition, and to show their necessities, has explained the laws for the production of vegetable life, in a simple and plain, yet thorough and irrefutable manner. Though at first these explanations may bear the imperfection incidental to all human productions, yet the pathway is clearly marked out, the goal of truth designated, and light abundantly furnished to lead those who sincerely seek to attain it.

It was not to be expected that opposition to long conceded notions would not be resisted, or that the promulgation of new views would not be attacked by some who had entertained different opinions hallowed by long association; and hence we find here some sneering at that which they have not the knowledge to understand nor the industry to learn, whilst in other places the doctrine of the "mineral theory" has been attacked with vigor, industry and learning. But who does not remember how all great discoveries have been resisted? how vaccination was hooted at? and how electricity and gas were placed with one of the greatest humbugs of the day? Yet no one feels safe now without vaccination. Gas for the purposes of light has become as common in our large cities as candles, and by the aid of electricity, time and space have become almost annihilated. None have ever been able yet

successfully to disprove the leading points of the doctrine; nor to show either by experiment, or prove by argument founded on them, that the mineral constituents are not of prime necessity in soils, that when deficient or absent they must not be supplied; nor does the boldest assume to know a priori which are deficient, save by the use of manures of known composition, by watching their effects and noting the results—thus offering costly, uncertain and slow experiments to the cheap, certain and speedily ascertained results of analysis.

The experiments made by Mr. Lawes, a gentleman of ability and great industry, prove entirely too much. If they prove any thing, they prove that ground bones, those which are dissolved, and various phosphates, including those of lime, magnesia, potash and soda, are entirely useless, and finally that the ashes of 14 tons of farm-yard manure are worse than useless, and that too "on land exhausted for the purpose."

Below I give his experiments:

	Bushels of Wheat per acre.
Unmanured,	16¾
700 superphosphate, (bones dissolved)	16¾
8 lots of various phosphates, average	16⅝
Ash of 14 tons of farm-yard dung,	16
14 tons of farm-yard dung,	22

These prove, if any thing, that the ashes of farm-yard dung are worse than useless—that is, that alkaline and earthy phosphates, magnesia, potash, soda and lime, are worse than useless on an exhausted land. Thousands in England have proven to the contrary by using those very substances and in some instances by their doubling their crops, in those instances where there were no mechanical obstacles and where the substances applied were either absent or deficient.

Mr. Lawes, to make his experiments subject of proof, should have had his soil analyzed, and if then with a deficiency of phosphates, the dissolved bones had done no good, there might be some grounds for supposing that mineral constituents were of no avail; certainly there would have been, if all the other substances were present in the proportion found in good wheat soils. If this were the case, then the mechanical texture of the soil was at fault, and could not supply the requisite quantity of organic matter. Experiments of this kind, in which every possible agency to produce a crop is not taken into consideration, are worse than useless. An experiment in some particular locations might show that Peruvian guano is not so valuable for a first crop even as a hundred bushels of lime. But if general conclusions from this were drawn and acted on, how often would it happen in other places that no benefit would be found from lime, whilst guano would, if used, have produced an abundant crop.

Let no experiment be received as proof of a doctrine in agriculture unless the composition of the soil, as well as its physical character, be shown. The fallacy to which Mr. Lawes' experiments would lead are so obvious as not to require refutation.

From all, then, that has been said, from the known and ascertained condition of soils of notorious fertility; from the composition of crops that are grown for food; from the effects of the application of manures, it is to be concluded that the productiveness of a soil *to the extent of the production of the plant is due:* 1. To the presence, in exact ratio, of the mineral constituents named above; 2. The condition in which these substances are found as to their solubility; and 3d. The capacity of the soil, as to its physical texture, to supply the growing plant with organic food from the atmosphere. The proportion of the several mineral constituents best adapted to produce fertility and the requisite physical structure can be found, or at least approximated to, by a large number of careful analyses made, in different seasons, of soils which are already productive. The kind and quantity of manures best adapted to renovate worn-out lands can be shown only by their careful analysis and the *noted* results of manures upon these lands. It is not enough to know that a particular manure is adapted to a particular soil. The most economical quantity, that which will give the greatest profit from the smallest outlay, should be shown, both as to present increase and future returns.

The above remarks lead us to the consideration of those substances which are used as

MANURES.

By manures are to be understood those substances which applied to soils, can either directly or indirectly supply plants with nourishment. This is a general definition of manures. It becomes special in reference to different soils, and they are then in this relation, whatever substances can supply the absence or deficiency of those constituents of the soil which are necessary to vegetation, either by supplying this absence or deficiency of themselves, or which by their action on the soil, can set free substances which may be present, but not in a form capable of assimilation by the plant. The most perfect knowledge, then, of the use of manures must be derived from a knowledge of their nature and composition, and also of the soils to which they are applied, and this is nothing more nor less than the science of chemistry.

In the application of all manures particular attention should be paid to their equal and thorough distribution through the soil, so that each plant may have its due supply. In the selection of a manure, particular attention should be given to its mechanical or

physical state. Many failures of manures are to be attributed not to the fact that the soil was not deficient in their constituents, but that the manure used was not in a fit state or condition when applied to the land to be used by the plant. I have seen ground bones sold in large lumps instead of an impalpable powder. It is evident that a long time must elapse before they, in the former state, can be used by the plant, and a large quantity employed if we wish to supply every part of the soil with them.

An acre of land contains 6,272,640 square inches; a pound av. 7,000 grs. It requires, then, about 900 pounds of any manure to supply one grain to each square inch of soil. If, then, in the application of 1,000 pounds of a manure, say twenty bushels of bone dust, and there be fragments of it weighing from one to two hundred grains, as is often the case, there must be in some places nearly from 1 to 200 square inches entirely destitute of manure.

In order to give to the soil manure in the proportion of one grain to each cubic foot to the depth of 12 inches, we must apply about four tons. If we have the manure in large lumps, does not the least consideration show us that a large part of the soil must be left unmanured, even though we apply a very large quantity, a quantity too costly, frequently, ever to be employed?

Manure only can act in supporting the plant when it comes in contact with and can be taken up by its roots. How important is it, then, to have it thoroughly distributed, which is impossible except it be in the finest possible state of division. This should be looked to when large quantities of cheap manures are applied, more especially, then, when costly manures are used in small quantities. When, for instance, we apply two hundred pounds of guano, if it be not beaten up very fine, and then most carefully applied, a large part of the crop will receive no nutriment, while some will have too much, and although the appearance of the crop may be satisfactory, still there will be much less of it produced than if the manures were evenly applied. The above observations apply to compost, stable manure, and more strongly to lime, but with much greater force to guano, bone-dust and other expensive manures used in small quantities.

The great effects produced by bones in a state of solution are due to their thorough distribution in the soil; and we find that liquid manures, though containing but a small proportion of the necessary elements, yet, nevertheless, act with great intensity; this intensity of action is due to their form and to the fact that though every part of the soil may receive but a small portion, yet no part of it is left unsupplied.

Sir Gilbert Blane caused experiments to be made with flax water, which although containing a small portion of inorganic matter, yet acted very powerfully, a fact due to the complete so-

lution of all the substances in it, so that when they were applied to land every part of the soil was supplied with some portion of it.

The *mode* of the application of manures is not sufficiently attended to in this country, though sometimes it is as important almost as the article used. Whatever this may be, the full measure of benefit from it cannot be obtained unless it be equally distributed, and this cannot be effected unless it be in the finest possible state of division.

LABOR IS NOWHERE SO PROFITABLY EMPLOYED as when *in reducing manures, before using them,* TO THE FINEST POWDER.

First in importance of all the manures is that with which every farmer has more or less to do, viz :

STABLE AND BARN-YARD MANURE.

From its origin we can readily see that it must possess *all* of the necessary constituents of crops. When we consider that all of the food taken by our domestic animals which does not go to increase their weight, and which does not pass off in breathing, is voided in the shape of manure, we may understand how valuable that manure must be. The structure of all living animals is continually wasting away, and its materials being carried out of the system. This waste is renewed by the food taken As long as the body grows more matter is taken as food than is passed as manure. When growth is stationary the waste and supply are equal, and when the weight of the body diminishes, then the waste exceeds the supply. Hence the manure of well fed animals which have obtained their growth is always better than that of young animals. Stable manure is a type of all other manures. It not only supplies all of the necessary constituents in a form fit for assimilation, but it also from its large proportion of vegetable matter furnishes carbonic acid, which serves to dissolve those materials which may be present in the soil, but not in a form capable of being used by the plant.

Since, then, in this substance we have all that we want, it becomes our duty to preserve it with the most careful attention. It is but poor economy to suffer the ammonia in stable manure to be carried off by the air, and the phosphates and alkalies to be wasted away by the rains and then buy guano at $46 per ton to supply their place.

In stable manure, especially, the ammonia very rapidly escapes. This is manifest by going at any time into a stable. The smell at once admonishes us that something is passing away in the air. This something is the most valuable constituent of guano, and for which in that manure of average quality we pay at the rate of 12 cents per pound. A most effectual mode to prevent its loss,

and at the same time involving but very slight cost and but little labor, is to scatter plaster (gypsum) over the manure in the stable and also over the heap. This causes the volatile principle to become fixed, so that it no longer escapes into the air. A few dollars thus expended will save as much manure of this kind as is frequently found in a ton of guano; from six to eight hundred per cent. can be made on all the money thus expended.

To secure this from loss by the air is not enough, for we gain nothing if we guard against the air and then suffer the rain to carry away every thing saved by our caution—mere saving at the spiggot and losing at the bung. For this reason the water which falls on stable or barn-yard manure should not be suffered to run off. When it does, it carries away all of its most valuable parts. There is so much carelessness, such a total disregard of economy in this respect amongst our planters and farmers, and such an entire variance from common prudence, as cannot either be explained or excused. Whilst very many have been induced to economize their manure, yet I have unfortunately seen many farm yards so situated as to lose all of their valuable matter before it is applied to the land. The most skillful Engineers and Chemists could not devise better locations to deprive their manures of all valuable properties than those selected by many of our farmers. A barn yard into which the stable manure is thrown is placed on the side of a hill with a southern exposure, subject to the full influence of the sun, and exposed to filtration, not only from the rain which falls on it, but that from contiguous buildings and sometimes from a contiguous field. Very often, too, it is near to a running stream to which the water from the yard has an easy flow, and thus, when the time comes for the application of the manure, its most valuable parts are polluting the atmosphere and the waters of our rivers, instead of fertilizing the adjacent fields.

If there be not enough of weeds, straw and litter thrown into the barn-yard to absorb and retain all the water which may fall in it, then convenient pits should be dug, filled with corn stalks, straw or other litter, into which the water should be conducted. Those pits should be so arranged that when one is filled its overflowings should run into the next one, so that all the liquid drainings could be saved and carried to the fields when wanted. Into these pits should be thrown all the refuse matter of *every kind pertaining to dwelling houses*, and over them plaster should be plentifully strewn. If this plan was universally adopted throughout the State, I am very sure that a much greater amount of manure would be annually saved, manure now suffered to escape, then would equal in value all the guano used in our State, and that too with but trifling labor and very slight expense. As it has been said that the consumption of sulphuric acid is a fair criterion of the civilization of a country, so it may with greater truth

be declared that the intelligence and industry manifested in the accumulation and preservation of manures is the best index of agricultural knowledge and improvement. The manure heap is a fair exponent of the thrift and knowledge of the farmer. Our numerous and valuable agricultural societies could do no better thing to conduce to agricultural improvement than to give liberal premiums to those having the most perfect modes for the collection and preservation of manure; that being attained, fertility of soil and increased production would necessarily follow. For the comfort of the stock, as well as for the preservation of the manure, the water falling on buildings adjacent to it should be conducted from the barn yards. To this species of manure lime in no state should ever be applied. That which is perfectly air-slaked is useless; water-slaked is quite prejudicial, and quick or caustic lime entirely deprives it of its most valuable properties. The use of this was quite frequent in our State previous to the publication of my last report. I am happy now to state that it is much less so than formerly, and hope soon to find it entirely discontinued.

In following out the recommendations which I have given above, to throw into the pits contiguous to stables and barn yards refuse matter of every kind pertaining to dwelling houses, I allude particularly to the fluid and solid excrements that usually accumulate about them. From these is prepared a manure called in commerce Poudrette, of very great strength and value.

The solid excrements of the human species are rich in phosphates of lime and magnesia, whilst the urine, or liquid excrement, is one of the most powerful and quick manures known, containing a large proportion of the elements of ammonia, (the most valuable part of Peruvian guano,) besides phosphates of lime, magnesia, potash and soda, all very quick and powerful manures.

An appeal to chemical analysis is not necessary to show the value of these, if we consider that before the period of full growth a large part, and afterwards all the food taken is, in an altered form, passed off as excrements from the body. The same elements then that originally produced all the corn, meat, &c., used as food, can be restored to the soil and continual fertility kept up, provided no part of the crop was exported. In every case nearly all that is consumed on the land can be restored to it, thus giving enough for the support of the population resident upon it. In China, which supports a larger population to the square mile than any other part of the earth, and where agriculture has obtained a high degree of practical perfection, human excrements are preserved with the greatest care, there being tanks placed along the most frequented highways for its collection. In French Flanders, too, and Belgium, districts of country where agriculture is at the highest degree of perfection, this manure is sought after and preserved with the greatest zeal. This should be the case every where.

In the country, when regularly thrown into pits, which should be annexed to every farm yard, from its small proportion it would be entirely divested of every thing repugnant, which serves in a great degree now to prevent its use.

The preservation and use of this kind of manure would in a few years produce a sufficient increase of the crops of the State to pay off all of its obligations; however trifling the amount on each homestead may be, yet when we multiply that amount by the number of those in the State, it will make a very large aggregate.

I am sure that I am not far from the truth in estimating the solid and fluid excrements of each individual to be worth at least $7 per annum, estimating it by the same rule which would make Peruvian guano worth $46 per ton. This would make the manure of the city of Baltimore alone annually worth more than one million of dollars. How much of this is lost—nay, worse than lost; how much of it serves to pollute the air, engendering disease and death, those can best judge who know what little attention is paid to this subject. The above are not mere speculations. They are founded on very careful calculations, based on facts collected and observed by many of the greatest philosophers in the annals of civilization.

BONE DUST, PHOSPHATE OF LIME, SUPERPHOSPHATE, BIPHOSPHATE OR DISSOLVED BONES.

The necessity of the chief elements of bones, phosphoric acid and lime, to the production of crops needs no proof, whether we examine the constituents of fertile soils, the crops cultivated for the support of men and animals, or the composition of men and animals themselves, which is from food furnished by the crops. In the present article I shall confine myself to the preparation and best mode of application of the phosphates, uniting as much brevity as possible, with explanations full enough for the good understanding of the subject.

The bones of all animals are composed mainly of phosphoric acid and lime, forming what is called phosphate of lime; besides these they contain a small proportion of phosphoric acid, in union with magnesia, phosphate of magnesia, carbonate of lime, soda and potash; the two last, and several other substances in very small proportions, of no practical value here. These are the mineral constituents. They contain, when fresh, about from 40 to 50 per cent. of organic matter, which is capable of affording ammonia by its decomposition. Bone dust as sold in the market usually contains from 60 to 70 per cent. of phosphate of lime. The drying, boiling and sometimes burning of the bones renders the quantity of mineral matter comparatively greater than is found in fresh bones. Besides in bones, combinations of phosphoric acid are

found in wood ashes, in guano, in poudrette, and in very small quantities in some marls and limestones. To supply phosphates we should either look to bones, to Mexican or Patagonian guano, but certainly not to the latter at its present price.

There has been lately discovered in New York and New Jersey what has been called mineral phosphate of lime. If these deposits, as to their quantity, answer the expectations of their discoverers, they will prove a cheap and abundant supply of phosphates. As soon as it may become a commercial article in our markets, I shall examine it as to its agricultural value in relation to other sources of supply, and make public the results. At present it is stated that the New Jersey mineral is less rich than the New York mineral in phosphate of lime. It is very probable that we have similar deposits in the upper sections of our State. I shall look most diligently for them. Should any exist they will prove a most abundant and cheap supply of this, one of the most costly and valuable articles of manure.

MODE OF APPLICATION.

The manner and form in which a manure is applied is frequently of as much importance as the manure itself. Bone dust is comparatively of high cost, and very often the form in which it may be applied is of great consequence. Bone dust should never be applied except in the finest powder, dissolved in sulphuric acid and mixed with ashes, or some fine compost, or in the liquid form. True economy, which is the judicious application of means, requires that it should always be dissolved before using it. In agriculture we have to deal with two varieties of the phosphate of lime; one, the bone earth phosphate or bone-dust, in its natural form; the other, the acid phosphate of lime, superphosphate, or biphosphate. One of the greatest boons which science has conferred on art is that of dissolving bones before using them. In the condition in which bones originally exist, and even when they are ground to the finest powder, they are still comparatively insoluble, and we must apply a large quantity to supply the growing crop. When dissolved by means of sulphuric acid they are then very soluble, can be spread much more equally over the soil, and will exert a much speedier influence on the crop. It is not out of place here to speak of some of the more important changes which take place on the addition of sulphuric acid to bone dust or phosphate of lime. Pure neutral phosphate of lime contains of

Phosphoric acid, - - -	48.50 per cent.
Lime, - - - - -	51.50 per cent.

Biphosphate of lime is composed of

Phosphoric acid, - - -	71.50 per cent.
Lime, - - - - -	28.50 per cent.

This latter compound is very soluble and is produced in this way. In chemistry we have what are called weak and strong acids. When a weak acid is united to a base, a stronger acid will expel it and seize on the base itself. We have a familiar example of this in the mixing of soda powders where tartaric acid is mixed with carbonate of soda; here the tartaric acid being the stronger expels the carbonic acid and unites to the soda—the carbonic acid causing effervescence as it escapes. When sulphuric acid is added to bones it drives a part of the phosphoric acid from their lime and unites to it, forming sulphate of lime, (gypsum, or plaster of Paris.) The phosphoric acid thus set free does not escape, as would carbonic acid, but either unites to a smaller proportion of lime, or is left alone in solution, according to the quantity of sulphuric acid employed. To convert 100 parts of pure phosphate of lime into the biphosphate, 45 parts of absolute or pure sulphuric acid must be added; we then shall have about 68 parts of biphosphate of lime and 77 parts of sulphate of lime or gypsum, and we have in the mixture biphosphate and sulphate of lime mixed mechanically together.

When this compound is added to the soil from its extreme solubility it is carried to every part of it, and there meeting with lime or other bases it is reconverted in the neutral phosphate again, or if it meets with potash or soda into the phosphate of these bases. So, although it may eventually be restored to the same compound, nevertheless a most important and vital point has been gained. When dissolved, it has entered into every pore in the soil, has come in contact with every grain of sand, has become most intimately blended with the earth to be cultivated; so that from its minute subdivision, every point in the soil can furnish to the plant this material for its support; for other things being equal, the solubility of bodies is in proportion to the fineness of their divisions, and all manures must be dissolved before they can act on vegetation. It becomes then a matter of great interest to the consumer to have his bone dust not only dissolved, but to have it treated afterwards with such substances as will not reproduce the original compound—if lime be employed, this will take place, and though we may have the bones reduced to a very fine state of division, yet we have to rely on mechanical means to mix them with the soil instead of the more thorough and complete mixture which takes place when they are applied in a soluble state, and thus reach every atom of the soil. This is a point of the highest importance and should always be *strictly* attended to.

Since sulphuric acid is that which is most usually employed to dissolve bones, it is necessary that something should be said in relation to it. In commerce it exists in two forms: brown or chamber acid is that which issues from the leaden chambers where it is made, and oil of vitriol is that which is produced when this

brown acid is boiled down and concentrated; the former is generally used for manufacturing purposes. Sulphuric acid differs very much in specific gravity and density; the heavier it is the more of *pure* acid it contains. *Chemically pure* sulphuric acid does not exist in commerce. In the purchase, then, of this article, it is very evident that persons not familiar with its properties are liable to continual imposition and cheatery. Its measure of capacity is no test of the quantity of acid. One carboy or demijohn of three gallons may contain only half as much real acid as another of the same size. The purchaser should always insist on a *written* guarantee being given as to the specific gravity of the article which he may buy, and should have it tested by some competent person.

On the next page I give from Turner's Chemistry, by Liebig & Gregory, 2d Part, 8th Edition, London, 1847, a table of Dr. Ure, showing the quantity of real acid contained in the commercial acids of different density, which may be very useful to those not having access to treatises on Chemistry.

Dr. Ure's Table of the Quantity of Oil of Vitriol, of sp. gr. 1.8485, *and of Anhydrous Acid, in* 100 *parts of dilute Sulphuric Acid, at different Densities.*

Liquid.	Sp. Gr.	Dry.	Liquid.	Sp. Gr.	Dry.	Liquid	Sp Gr.	Dry.
100	1.8485	81.54	66	1.5503	53.82	32	1.2334	26.09
99	1.8475	80.72	65	1.5390	53.00	31	1.2260	25.28
98	1.8460	79.90	64	1.5280	52.18	30	1.2184	24.46
97	1.8439	79.09	63	1.5170	51.37	29	1.2108	23.65
96	1.8410	78.28	62	1.5066	50.55	28	1.2032	22.83
95	1.8376	77.46	61	1.4960	49.74	27	1.1956	22.01
94	1.8336	76.65	60	1.4860	48.92	26	1.1876	21.20
93	1.8290	75.83	59	1.4760	48.11	25	1.1792	20.38
92	1.8233	75.02	58	1.4660	47.29	24	1.1706	19.57
91	1.8179	74.20	57	1.4560	46.48	23	1.1626	18.75
90	1.8115	73.39	56	1.4460	45.66	22	1.1549	17.94
89	1.8043	72.57	55	1.4360	44.85	21	1.1480	17.12
88	1.7962	71.75	54	1.4265	44.03	20	1.1410	16.31
87	1.7870	70.94	53	1.4170	43.22	19	1.1330	15.49
86	1.7774	70.12	52	1.4073	42.40	18	1.1246	14.68
85	1.7673	69.31	51	1.3977	41.58	17	1.1165	13.86
84	1.7570	68.49	50	1.3884	40.77	16	1.1090	13.05
83	1.7465	67.68	49	1.3788	39.95	15	1.1019	12.23
82	1.7360	66.86	48	1.3697	39.14	14	1.0953	11.41
81	1.7245	66.05	47	1.3612	38.32	13	1.0887	10.60
80	1.7120	65.23	46	1.3530	37.51	12	1.0809	9.78
79	1.6993	64.42	45	1.3440	36.69	11	1.0743	8.97
78	1.6870	63.60	44	1.3345	35.88	10	1.0682	8.15
77	1.6750	62.78	43	1.3255	35.06	9	1.0614	7.34
76	1.6630	61.97	42	1.3165	34.25	8	1.0544	6.52
75	1.6520	61.15	41	1.3080	33.43	7	1.0477	5.71
74	1.6415	60.34	40	1.2999	32.61	6	1.0405	4.89
73	1.6321	59.52	39	1.2913	31.80	5	1.0336	4.08
72	1.6204	58.71	38	1.2826	30.98	4	1.0268	3.26
71	1.6090	57.89	37	1.2740	30.17	3	1.0206	2.446
70	1.5975	57.08	36	1.2654	29.35	2	1.0140	1.63
69	1.5868	56.26	35	1.2572	28.54	1	1.0074	0.8154
68	1.5760	55.45	34	1.2490	27.72			
67	1.5648	54.63	33	1.2409	26.91			

It will here be seen that every 100 parts of sulphuric acid of specific gravity contains 1.8485, about 81½ per cent. of real acid, while that at 1.3884 contains only 40 per cent., about one-half as much real acid. From this will be seen the reason why I have given the advice as to a guarantee.

MODE OF TREATMENT AND QUANTITY OF ACID TO BE USED.

Without going into the reasons and showing the calculations from which they were formed, I will here state that for every hundred pounds of bones to be acted on, about thirty-three pounds of sulphuric acid of specific gravity of 1.70 should be used; of course the quantity of commercial acid is to be increased when it is of less specific gravity. The bones should be finely ground and then moistened with water, after which the acid should be gradually added, and the mass thoroughly stirred. This is important to be attended to, as otherwise a coating of sulphate of lime will form over the particles of bones and prevent the further action of the acid. They should be suffered to stand for ten days or a fortnight, be very frequently stirred, and then their superfluous moisture dried with saw dust, wheat chaff or any convenient substance except lime, for the reasons before given. The handling of the sulphuric acid requires caution, as it will excoriate the skin or burn the clothes of those who handle it if it comes in contact with them. The best mode is to have a bent leaden tube or siphon, with a stop-cock at one end; this should be filled with water, the short end placed in the sulphuric acid, the long one with the stop-cock over the bones; the stop-cock is now to be turned, and the acid can in this manner be applied without any risk or danger to those using it.

QUANTITY AND COST PER ACRE.

The proper quantity of dissolved bones, as near as I can know from all the information which I have upon the subject, is about five bushels to be sown broadcast at the time of sowing or planting the crop. The cost, exclusive of labor, which is but slight, will be of

Bones, 5 bushels, 250 lbs., at 50 cents per bushel,...	$2 50
Sulphuric acid, 83 lbs., 2½ cents per lb.,...........	2 07½
	$4 57½

Or at most five dollars per acre. This will in every instance, if judiciously applied, produce an increase, equal to the above sum in every crop for four or five years, and then leave the land much better than before its application. To those who are in the habit of manuring fields with stable manure, this quantity added will enable them to dispense with an amount of stable manure double in price to the above, make its action more permanent and produce better crops. It should in every instance be thoroughly mixed with the manure before being applied. I offer this suggestion particularly to those who are in the habit of gardening in the neighborhood of our cities, and to whom the cost of hauling stable

manure alone is very great. Another mode for the application of bone dust is in the liquid form. I strongly recommended this mode of application in my last report to your honorable body. (Page 37, House copy.) The reasons which I then gave remain in full force, and the experiments there detailed still have my entire confidence, and I strongly urge this mode of application as cheap and certain, and one that in its results will amply remunerate for the labor expended on it. For details of the mode to be employed and the experiments given, I respectfully refer those interested to that report. I have been thus particular in giving precise directions as to the mode of preparation of bones by this process, because I am certain that in a few years they will come into very general use. In many of our soils the elements of bones are very deficient, and their use will be greatly extended. I advise every planter and farmer to collect and preserve them, even if they be now skeptical as to their value, for in a few years they will see their efficacy and will then regret not having followed the advice I have given them. Farmers should take every occasion to manufacture their own manures, as they have had no certainty of the purity of the articles bought, and therefore have incurred great loss. I shall show, when speaking of guano, how this has been the case in relation to this article; and if so in this, how much more likely is it to be the case in a manufactured article, where no check exists to prevent the adulteration or impurity and which few have the ability to detect? The value of dissolved bones depends on their phosphate of lime being converted into biphosphate of lime; and to show how important this is, it is enough to recollect that whilst the former is not worth more than $1\frac{1}{2}$ cents, the latter is worth from 8 to 9 cents per pound. The loss likely to be sustained by purchasers of an inferior article is sufficiently manifest, when it is considered that that inferiority may result from the ignorance as well as the dishonesty of the manufacturer. By manufacturing for themselves, the consumers will escape loss from either cause. The points here in reference to which I wish to call particular attention of the agriculturists, are:

1. That bones should be used in their most soluble form—that is, dissolved in sulphuric acid, as before directed.

2 In preparing the mixture the bones should be as fine as possible.

3. That the quality of the sulphuric acid employed should be well ascertained and paid for accordingly.

4. That lime, or substances containing much of this, should not be used to dry the mixture.

5. That dissolved bones may be very profitably united with stable manure.

6. That they may be employed with benefit either at the time

of sowing wheat or planting corn, or may be used as a top dressing to wheat in the spring; and

7. That the purchaser should well ascertain the composition of the manure when bought, as it may and does vary from many causes.

Under this head I shall also speak of some large deposits of phosphate of iron which I have examined. "Earthy phosphate of iron. Blane Eisenerde Fer phosphaté terreux. H. Blue iron earth. The color of this variety on its first exposure is gray, yellow, or greenish white, or with a very slight tinge of blue, afterwards it becomes blue of different degrees of intensity," in some instances equal to deepest indigo. "It occurs massive, disseminated in or coating other substances, and is sometimes bare, and occasionally cohering and with an earthy fracture, it is dull, meagre to the touch, soils the fingers slightly and is light. B. B. It becomes reddish brown and then melts into a brownish black slag, attractable by the magnet. It occurs in clay or mud more or less mingled with animal matter, from which the phosphoric acid is conjectured to have proceeded? Also in argillaceous deposits in many places where it seems to have had its origin from the decomposition of animal substances. It has been brought from Styria, Corinthia and Greenland. The friable varieties have been met with in forming excavations in the river mud of the Isle of Dogs, in the same deposit at Toxteth, near Liverpool. On the surface of morasses in several of the Shetland Isles, at Ballagh, in the Isle of Man, accompanying animal matter as the bones of the elk and deer. Bog iron ores are frequently more or less contaminated with phosphate of iron, and the cold short quality of the cast iron obtained from them, has been supposed to be owing either to the direct combination of phosphoric acid with the metal in the process of smelting, or to its not leaving the iron with which it was already mixed in the ore. It is evident, however, that phosphoric acid could not escape decomposition in the intense heat of the smelting furnace."* (Phillip's Min., Boston 1844, p. 367.)

This deposit will prove of great value to their immediate localities as a substitute for bones. Large deposits occur on the farm of Mr. James Mulliken, in Prince George's, and I have also noticed it in several other places in the same neighborhood. When pure it contains about 28 per cent. of phosphoric acid. The average of six different analyses of the above deposit, taken and made at different times, shows 16 per cent. of phosphoric acid.

So that every hundred pounds of the above substance contains as much of phosphoric acid, the chief valuable constituents of bones, as about 64 pounds of fresh bone dust. One hundred bushels then thoroughly mixed with lime will contain the same amount of

* I have obtained 6 per cent. of phosphoric acid from cold short pig iron. *Extract of a letter from D. Stewart.*

valuable elements as 64 bushels of bone dust. A much larger quantity will have to be applied than of bones, because the phosphate of iron is very insoluble, but on this account its effects will be much the more permanent. It exists in great abundance in the above localities, and I hope will be used with signal benefit. In the coming season I shall subject it to various tests in order to devise the best means for speedily extracting its phosphoric acid. There is a large *peaty deposit* in Anne Arundel county, on the farms of the Messrs. Hodges & Harwood, and the Hon. J. S. Sellman, which contains also some of the phosphate of iron. It is very rich in inorganic matter, containing about 20 per cent. of various salts, useful in vegetation, and about fifty-five per cent. of organic vegetable matter; when exposed in heaps to the sun for a short time, it is easily burnt, and its ashes prove a very valuable manure.

It has been used to a great extent by the last named gentleman with immediate effects, equal to guano, and the end of its influence is not yet. The marsh from which it is derived, a few years ago would have been sold for almost any price, now scarcely any sum would buy it. Besides its agricultural value this deposit is a subject of deep interest in other respects, the discussion of which would be out of place here.

LIME.

No substance, with the exception of stable manure, has been so long and so generally used as that which heads this article. There is none concerning which there has been such a variety of opinions as to its use at all, the quantity per acre to be used, the time and mode of its application. The Romans and some of the so-called barbarous nations of Germany used it long before the Christian era. "Edui et Pictones agros calce uberrimos fecit." "The Edui and Picts made their fields very rich by lime," says an ancient author. In the form of marl, too, it has been used for a very long time; and though this be an age of progress, the progress in agriculture has very lately commenced. Leases as far back as the time of the reigns of Edwards I and II have conditions annexed compelling the use of marl by tenants.* The Chartæ Forestæ, passed 1225, mentions the right of sinking marl pits. It was probably also used in the time of Pliny, in France and Britain. The diversity of sentiment which has and still exists in relation to lime is a sufficient proof that heretofore all the causes which promoted or prevented its efficiency could not have been known. A thousand different opinions have been promulgated as to its mode of action, and a thousand contradictions to those opinions, like the opinions themselves, all based on experiment and practical observation. How little this empirical practice has

* See first volume British Husbandry, London.

contributed to our fund of actual wisdom and how slightly it has promoted agricultural science, its present condition will best answer. There was ever hidden one of the main causes on which the influence of lime depended, viz: the precise composition and character of the soil. The necessity of this was fully conceded by the attempts given to show its composition in general terms. The adaptation of lime to stiff clays and light clays, to clayey loams and loamy clays, to sandy loams and loamy sands, to stiff and light sands, are all so many attempts to give the nature of the soil; all so many concessions to the principle that its exact character should be known, since if a slight knowledge of it be of any utility, a more extended and special acquaintance with it will be of proportionably greater benefit. It will be remembered that I defined manures to be those substances absent or deficient in the soil which afforded nutriment to plants, either by their own material or which by their action on the soil would cause its dormant materials to assume a form capable of being used by plants. Lime performs both of these functions. It enters largely into the composition of all plants used by men and animals; it breaks down and disintegrates the particles of soil and causes them to assume a form capable of being used by plants; and furthermore, by its action on organic matter, it destroys its combinations and gives its material to plants. It will thus be seen that it has a wide range of operations. Some limestone contains also the elements of bones, with a little gypsum, in their composition, whilst others have a very large proportion of another necessary substance to plants, which is magnesia. The phosphate and sulphate of lime, though existing in some limestones, yet generally are in such small quantities as not to affect their agricultural value—limestone being valuable in proportion to the quantity of lime or magnesia which it contains. As this is a standard article of manure, and very extensively used, I here insert what I stated in my last report to your honorable body, with the addition of other analyses made since that time, it being my intention to make analyses of all the limestones which may be sold and used in this State for agricultural purposes:

Lime, as used in agriculture, is obtained either from limestones, oyster shells, Indian shell banks, or marl. In all of these different substances it exists naturally in the state of carbonate. Limestone is subjected in kilns properly prepared, to a degree of heat sufficient to expel their carbonic acid, and becomes quick lime, (oxide of calcium,) On exposure to the atmosphere, it absorbs from it carbonic acid, and returns into the same chemical condition as it existed in the limestone. On the addition of water to quick lime, heat is evolved, and not a mere mixture, but a chemical union takes place between the water and the lime, and a hydrate of lime is formed, or in common language, it becomes *water-*

slaked. This compound contains of lime above 76 per cent., while air-slaked lime contains but 56 and nearly one-third per cent. The lime obtained from oyster shells is reduced to powder in the same manner as stone lime, and is, in every respect, identical with it, as far as the lime is concerned. It contains, however, another substance, phosphate of lime—i. e., lime associated with phosphoric acid, the same thing which gives bones their peculiar value. This forms from one and a half to two and three-quarters per cent. in oyster shells. So that in them we have all the properties of lime, with those of bone dust in that quantity superadded. Oyster shells, also, contain a small quantity of magnesia, but not enough to influence their agricultural value. We generally obtain lime from oyster shells purer than from common limestone.

The analyses of the following specimens of lime that had been sold for agricultural purposes, and comprising all those used in that part of Maryland which I have visited, will show their composition.

Lime from North River,* commonly called "New York Lime," is composed of

Water,†	17.70	per cent.
Lime, as quick lime,	37.30	"
Magnesia,	21.20	"
Sand, clay and iron,	23.80	"

The specimens of the lime were taken from the load in the condition in which it is sold; and I may here remark that all of the specimens were taken from lots which had been sold. The proportions given are by weight and not by measurement.

READING LIME—PENNSYLVANIA.

Water,†	1.40	per cent.
Sand,	5.80	"
Clay and iron,	10.10	"
Lime, (quick lime,)	52.29	"
Magnesia,	30.30	"

SCHUYLKILL LIME—NO. 1.

Water,†	12.80	per cent.
Sand,	4.00	"
Lime, (quick lime,)	35.00	"
Magnesia,	40.54	"
Clay and iron,	7.60	"

* This lime is furnished on the James river for about 6 cents per bushel.

† Unslaked.

SCHUYLKILL LIME—NO. 2.

Sand,	6.50	per cent.
Clay and iron,	5.00	"
Lime,	62.00	"
Magnesia,	26.00	"

SCHUYLKILL LIME—NO. 3.

Water,*	3.26	per cent.
Sand,	6.50	"
Clay and iron,	5.00	"
Lime,	60.24	"
Magnesia,	25.00	"

SUSQUEHANNA LIME—NEAR WRIGHTSVILLE.

All of the specimens unslaked, contained of

Sand,	4.85	per cent.
Iron and clay,	7.16	"
Lime,	73.00	"
Magnesia,	15.00	"

NO. 2.

Sand,	7.21	per cent.
Iron and clay,	3.32	"
Lime,	68.06	"
Magnesia,	21.40	"

NO. 3.

Sand,	11.02	per cent.
Iron and clay,	6.14	"
Lime,	71.63	"
Magnesia,	11.20	"

BALTIMORE COUNTY LIME.

The average of eight different analyses of the air-slaked lime gave of lime as carbonate, i. e., air-slaked lime, 81.4 per cent.

MONTGOMERY COUNTY LIME.

The average of various analyses made of the "Breccia marble, Calico limestone," found in Montgomery, from which the pillars in the House of Representatives at Washington are made, is of

Sand,	12.25	per cent.
Iron and clay,	1.00	"
Lime, as carbonate,	70.50	"
Magnesia,	15.00	"
Other constituents not worthy of estimation,	.25	"

*Unslaked.

There are also brought down by the Chesapeake and Ohio Canal two varieties of limestone, differing very much in their color, but in nothing else, except very slightly, as the following analyses will show:

BLUE OR DARK COLORED LIMESTONE.

Sand,..................................	1.90	per cent.
Clay and iron,.........................	60	"
Lime, as carbonate,....................	97.50	"
Magnesia, ...	00	"

WHITE LIMESTONE.

Sand,..................................	2.15	per cent.
Clay and iron,.........................	75	"
Lime,..................................	97.15	"
Magnesia,..............................	00	"

These are limestones of very great purity, and to soils requiring only lime would be the best that could be used.

The above are the average of eight different specimens of each kind examined. Each specimen differed but very slightly from the other, the limestones being very uniform in their composition.

LIMESTONES FROM HOWARD COUNTY.

Specimen from Mr. G. Ellicott, from near Rattlesnake Springs. Full of dark, irregular circular specks. (Mica.)

No. 1.

Sand..................................	26.15	per cent.
Iron and Alumina,.....................	8.10	"
Lime as carbonate, (air-slaked,)......	63.25	"
Potash and Soda,......................	1.00	"
Magnesia, ...	1.36	"
Phosphoric acid, (a trace.)...........		
Sulphuric acid, (a trace.)............		

No. 2.

Sand,.................................	10.50	per cent.
Alumina and iron,.....................	3.20	"
Lime, as carbonate,...................	78.20	"
Magnesia, as carbonate,...............	7.60	"
Potash and soda,......................	50	"
Phosphoric acid, Sulphuric acid, } none.		

LIMESTONE FROM NEAR CLARKSVILLE.

From Wm. Clarke, Esq.

No. 1.

Sand, ...	1.50	per cent.
Iron and clay,........................	.45	"
Lime, as carbonate,...................	84.20	"
Magnesia, as carbonate,...............	12.00	"
Lime, as phosphate,...................	1.00	"
Potash and soda,......................	.20	"

No. 2.

Hard, compact, light leaden color, with very many white glossy specks in the fracture.

Sand,	10.00	per cent.
Iron and alumina..	3.00	"
Lime, as carbonate..	76.50	"
Magnesia, as carbonate,.	10.00	"
Potash and Soda,.	.30	"
Lime, as phosphate,.	.40	"

No. 3.

Very hard and compact, of a grayish color, in layers about half an inch in thickness. Separated by very thin strata of mica, the layers easily separated. This would make fine building stone.

Sand,	19.50	per cent.
Iron and clay,.	3.60	"
Lime, as carbonate,	70.00	"
Magnesia, as carbonate,.	6.25	"
Potash and soda,.	.50	"
Phosphate of lime,.	.10	"

Mr. Watkins', from same neighborhood:

No. 1.

Sand,	9.38	per cent.
Iron and alumina,.	3.25	"
Lime, as carbonate,.	76.10	"
Magnesia,.	9.40	"
Potash and soda,.	.25	"
Lime, as phosphate, (bone dust,)	.10	"

No. 2.

Sand,	1.65	per cent.
Iron and clay,.	.50	"
Lime, as carbonate,.	85.50	"
Magnesia, as carbonate,.	11.40	"
Lime, as phosphate,.	.80	"
Potash and soda,.	.05	"

No. 1 of Mr. Clark's and No. 2 of Mr. Watkins' are first rate limestones for agricultural purposes. They exist in great abundance, and can be conveniently quarried.

LIME FROM INDIAN SHELL BANKS—NO. 1.

Specimen fully slaked:

Sand,.	3.00	per cent.
Clay and iron,.	.30	"
Lime as carbonate,.	94.10	"
Lime as phosphate, i. e., bone dust,.	2.20	"

LIME FROM INDIAN SHELL BANKS—NO. 2.

Sand,	2.00	per cent.
Lime as carbonate,	95.15	"
Lime as phosphate,	2.20	"
Clay and iron,	.60	"

LIME FROM INDIAN SHELL BANKS—NO. 3.

Sand,	6.25	per cent.
Clay and iron,	.15	"
Lime as carbonate, i. e., air-slaked	91.20	"
Lime as phosphate, i. e., bone dust,	2.30	"

N. B. The numbers 1, 2, 3, affixed to the "Lime from Indian Shell Banks," "Schuylkill Lime," and "Susquehanna Lime," only denote the order in which they were examined.

NORTH RIVER LIME.

Specimens obtained from Worcester county.

Water,	7.00	per cent.
Sand, clay and iron,	11.90	"
Lime,	56.00	"
Magnesia,	25.00	"

GAS HOUSE LIME—NO. 1.

Water and free sulphur,	9.20	per cent.
Sand,	4 00	"
Clay and iron,	1.00	"
Lime as carbonate,	80.00	"
Lime as sulphate, i. e., gypsum,	3.00	"
Lime as phosphate,	2.00	"

GAS HOUSE LIME—NO. 2.

This specimen had been exposed to rain.

Sand,	6.00	per cent.
Sulphur, (free,)	.90	"
Water,	13.00	"
Lime as carbonate,	68.75	"
Lime as sulphate, (gypsum,)	9.30	"
Lime as phosphate,	1.90	"

Gas house lime is obtained from oyster shells, and is used to cleanse the carburetted hydrogen, (the gas used for light,) from sulphuretted hydrogen, (that which is easily recognized by its smell, in the neighborhood of the gas house.) This lime always contains a portion of sulphuretted hydrogen, depending on the quantity of sulphur in the coal from which the gas is made.

When exposed to the atmosphere, the sulphuretted hydrogen, (hydro-sulphuric acid,) loses one of its elements, and becomes converted into sulphur. The sulphur thus formed, by further exposure to the air becomes changed into sulphurous acid, and whilst

in this state, would rapidly evaporate, but lime being at hand, it unites with it, forming a salt of lime, called sulphite of lime. On more prolonged exposure, the sulphurous acid becomes changed into sulphuric acid, (oil of vitriol,) which unites to the lime, and forms sulphate of lime, (gypsum.)

There not being a sufficient quantity of sulphur present to make enough of sulphuric acid to unite with all of the lime, a part remains as carbonate of lime.

It will be seen from the above short description of the changes going on in gas house lime, that at certain periods we have in it: 1st. Sulphuretted hydrogen;—2d. Free sulphur;—3d. Sulphite of lime; and 4th. Sulphate of lime;—at one and the same time. Phosphate of lime is always present, and undergoes no change.

When it has been exposed for some time, we then have in it only gypsum, air-slaked lime, and the phosphate of lime. Should this lime be applied when first taken from the gas house, after being used to purify gas made from coal, containing a large proportion of sulphur, its action will be as follows: Whilst the sulphur remains unchanged, the usual effects of lime will be produced; when it becomes converted into sulphurous acid, it will not only counteract the good effects of the lime, but destroy all vegetation; when the sulphurous acid becomes changed into sulphuric acid gypsum is formed, and we have its effect superadded to air-slaked lime. Gypsum, as has been *demonstrated* by Liebig, is decomposed by contact with the ammonia of the atmosphere, one of its elements uniting itself to it, thereby *fixing* it—in other words, destroying its volatility. But its use does not stop here—*it also affords sulphur, which is absolutely necessary to the formation of the nutritious parts of all substances used as food by men or animals.*

That the above will be the effect of gas house lime, under certain conditions, there can be no doubt. It contains sulphuretted hydrogen; this sulphuretted hydrogen *must* become converted into sulphur; this must and does become converted into sulphurous acid; but sulphurous acid and its salts, we have the highest authority for saying, will, "even in very minute quantities, destroy all vegetation."—*Christison on Poisons*, p. 750. And I am assured by a gentleman of the highest authority, that the application of from thirty to fifty bushels per acre destroyed one crop, and that after that it acted well.

I have also known plants in a green house destroyed by fumigations of sulphur, sulphurous acid being formed. When sulphuric acid is formed in the gas house lime, as formed it must be, gypsum at the same time comes into existence; and we will have its action and that of air-slaked lime manifest, provided the soil to which it is applied be deficient in sulphates and lime.

What quantity of sulphuretted hydrogen, or free sulphur, must

exist in the gas house lime at the time of its application, sufficient to produce deleterious effects, has not been as yet determined. There is the same poverty of *exact* knowledge in relation to this, as unfortunately there is in regard to other substances used as manures. The specimen marked No. 2, containing nearly one per cent. of free sulphur, was applied on growing wheat, at the rate of about one hundred bushels to the acre, by a gentleman whose statement can be implicitly relied on, with very good results; not the slightest injury was experienced. We thus have *one fact*, and that is, that gas house lime containing (.90,) equal to nine-tenths of one per cent. of sulphur, when used as a top-dressing to wheat in the winter, is beneficial.

The injurious effects which have resulted from its application, and its known properties, admonish us, however, when ignorant of its exact composition, *not to apply it to a growing crop*, nor *to a soil that is to be immediately cultivated;* when containing a large proportion of sulphur, to apply it to a soil abounding in *weeds*—which are pests to cultivation—and to meadows, some time before seeding them, to destroy all grasses likely to injure the hay crop. We can also safely say that, when applied to a soil deficient in sulphates and lime, the combined effects of gypsum and common air-slaked oyster shell lime, will be experienced. When its composition is unknown it should be applied to the surface one season before the crop is planted.

From the above analyses, the great difference in the various lime used *indiscriminately* for agricultural purposes can be seen at a glance—some containing forty per cent. of magnesia, and some none—some containing near ten per cent. of gypsum, and some none—some having twice as much lime as others, and no magnesia. If every soil was exactly alike, could it be possible that each of these limes would be equally beneficial? If the oyster shell lime should be the best application, see what a loss would be incurred by the application of Schuylkill lime, No. 1, containing not half as much lime. If, on the other hand, this lime, (the Schuylkill,) should be the best—as it is for some soils—consider the loss in applying oyster shell lime, and thus withholding from them forty per cent. of magnesia.

But when we remember that many soils contain an abundance of magnesia, and some scarcely any, the loss in applying to the first a lime containing more than fifty per cent. of what is already present in sufficient abundance, is greatly increased. The same remark is equally true in relation to the soil containing a mere trace of magnesia, when we apply to it lime also containing none. In each case our expense receives no remuneration; our efforts at improvement are useless; we labor in vain. That many soils have an abundance of magnesia, and some a mere trace, is an unquestionable fact. That the limes used for agricultural purposes

have the same difference in composition, is a truth beyond cavil. Now, how can those limes be economically applied by one ignorant of their composition, and ignorant of the composition of the soil? How can we arrive at the constituents of each? How can this knowledge, necessary, *absolutely* necessary, be obtained but by an analysis, both of the lime which we apply, and of the soil to which it is applied?

When it is remembered that magnesia is as necessary to constitute a good soil as any other one substance whatever, and that being absent or deficient, it must be supplied, how can its absence or deficiency be known, without a chemical analysis of the soil? And, even when this is ascertained, how can the right lime be applied, without an analysis of it, to see whether or not it contains magnesia? Let a soil containing an abundance of magnesia, but deficient in lime, be treated with the Schuylkill, Reading, or New York lime. The quantity of lime in these varieties will doubtless increase the crop and permanently improve the land, but how immeasurably greater would have been the benefit from oyster shell or Baltimore lime? Many sensible, practical men purchase Schuylkill lime, when they would not have our common lime given to them, because they, by experiment, know the value of the one and the worthlessness of the other to *their* soil. Many, again, in the same way, have found out the superiority of oyster shell lime to all others. Should not the expense incurred by experiment have been saved to them? This knowledge could and should have been afforded. *The whole aim of the application of manures being the greatest yield in crops, from the smallest outlay* of money, it is not enough for a farmer to know that the application of a particular substance does *well;* he should not be satisfied unless he *knows* that it is the *best* for his particular soil which can be used. That different substances, when applied indiscriminately to all soils, must be productive of disappointment and loss, is so apparent that I shall not pursue the subject any farther. In the application of millions of bushels of lime, decidedly differing in their composition, upon soils equally different from each other, with no rule to guide, no law to direct, a hundred times more money is annually lost to the agricultural interests of the State, than the amount of all the appropriations ever made for its benefit.

If the office of Agricultural Chemist had shown nothing but the proper adaptation of particular varieties of lime to particular soils, the State would derive a hundred times more benefit from it than the cost has been for its maintenance. I will not now say more on this subject. Axioms admit of no demonstration—self-evident truths need no proof.

I have found, and I believe I am the first to notice the fact, that the proportion of phosphate of lime varies with the localities in which oyster shells are found. As we approach the ocean, the

phosphate of lime in them increases. I have made many analyses of them for the estimation of phosphoric acid, and find this law to be universal. So that, other things being equal, the shells increase in value as they approach the ocean.

Shell banks are another source from which lime is supplied to soils. These shell banks are deposits by the aborigines of the country, and frequently cover an extent of from 1 to 40 acres, to the depth of from 6 inches to as many feet. As those who have never seen these social relics of the "poor Indian" have questioned the mode of their deposition, I will state the reasons for the belief of their Indian origin: 1. They are always found near the water's edge, on the slope of a hill, with a southern exposure, sheltered from the north and north-west winds. This is a position which the Indians would naturally select to enjoy their repast on the delicious article of food which the shells contained. 2. The bones of many animals, such as deer, bears, and numerous small game, are found intermixed with the shells, not in a state of integrity, but *broken*, showing that they came there not by the death of the animals in a natural manner, but were brought for the purpose of being consumed as food. 3. There are found, also, with those shells numerous small pebbles, evidently used to break off the edge of the oyster, in order to open them with greater facility. 4. There are also found with the shells Indian arrow heads, battle axes, pipes and various domestic implements that had been left by the tribes after feasting. Another and most conclusive reason against the opinion that these shell banks are mere oyster beds, left exposed by the retreating of the waters, is, that the shells are all separated, and no two lying together will fit each other; a large shell overlies one which is very small, and no one seems to be the fellow of its neighbor. These shells, moreover, lie frequently in heaps surrounding a cavity, showing as if a particular family sat together, consumed their food and threw the shells around them. The use to which the remains of the food of the Aborigines are applied is a striking proof of the benefits conferred on the human race by civilization. The refuse matter of their feasts is applied to the growth of food by another and a strange nation, who have extinguished their council fires, exterminated their race, and only remember their names amongst the traditions of the past.

From long exposure to atmospheric influence, and other causes, the shells become disintegrated, and readily crumble on free exposure to the air. Again, after the lapse of a considerable period, they become very much disorganized by another process. At first a little moss forms on the surface of the shells; this takes up enough lime that has been dissolved by the carbonic acid of the atmosphere to give support to a higher order of vegetation. This vegetation, by its decay, furnishes food for a succeeding generation of plants, and by an increased supply of carbonic acid dis-

solves more lime to supply another generation. This, in its turn, dying, furnishes increased means for the solution of the shell, until in many cases these banks are covered with the most luxuriant vegetation, and support large trees. The layer of matter covering the shells is called "shell mould," and consists of shells in a very comminuted state, and the organic and inorganic remains of the plants to which it owes its formation. A little reflection will at once show that this mould must prove a most valuable manure, being nothing but the remains, the ashes, so to speak, of plants, mixed with a large quantity of oyster shells, in a very minute state of division.

This mould contains of air-slaked lime, by the average of fifteen different analyses, 45.6 per cent., being more than half as good as common agricultural lime, and when we also consider the other matters in this mould, the ratio to limestone is much increased. It is almost needless to say that the lime in this *mould* is identical with that in limestones, fresh shells, &c., and will act equally as well. A custom has prevailed, to a very injurious extent, of applying the mould together with quantities of large, coarse fragments of shells. I cannot too strongly reprobate this mode of using the banks. These large fragments take up much space in the soil that should be filled by other matter, injure its texture and render the crops grown on it very liable to *burn* or *fire*. Though these shells be composed of lime, it is not available but in a very slight degree to the use of crops. Lime, to be serviceable, must be in the state of very fine powder, and intimately incorporated with the soil. When it exists in shells of any size, it does almost no good by its presence, and, as I have before said, *injures* the texture of the soil. For all present practical purposes pebble stones would be equally beneficial.

The best way to use these shell banks is to have a sieve fixed with a slight inclination. Against this the shells should be thrown as when persons wish to free sand from gravel. The fine particles which pass through the sieve should be applied as they are, whilst the coarse shells which do not pass through should be put into kilns and burnt. In this way no part of these valuable deposits would be lost; all would be saved for agricultural improvement, thereby increasing the quantity of crops, and augmenting the value of land, instead of retarding its improvement, as is the case when coarse shells are applied. The lime from these old shells is equally as valuable as that derived from those which are recent. Some of the best crops, and the finest land, have been produced *solely* by the application of shell mould and lime burnt from shell banks.

MARL.

The term *marl*, in the sense in which it is used in the district of country where my labors have been, is assigned to two sub-

stances distinct in their physical properties, and essentially different in their chemical composition. This difference is denoted in its name by the addition of *shell* in the one instance, and Jersey or Green Sand in the other.

Many of the class of green sand marls exist in the tide-water counties on the Western Shore, but none which I have examined are worth the expense of their application. In every instance where no analysis has been given of samples of this marl sent to me, it is because it is valueless. There may be, and I do not doubt are, many deposits of marls in these counties which I have not examined, because I have not had any specimens of them. I will hereafter, however, examine any that may be sent to me and give their results. A strong indication of the true green sand is the existence of peculiar shells in them. The form of one of them is particularly striking, resembling very much a serpent coiled on itself without a head. These are called Ammonites and have often been mistaken for petrified snakes. In Walter Scott's beautiful poem of Marmion is given a fanciful legend of their origin, founded on this resemblance. He makes the nuns of Whitby, who had come with their Abbess to St. Cuthbert's Holy Isle, when speaking of the power of their Saint, to say—

"And how of thousand snakes—each one
Was changed into a coil of stone,
When holy Hilda prayed
Themselves within their holy bound,
Their stony folds had often found."

The shell marl, as may readily be supposed from its origin, owes its valuable properties to lime, which exists in it in the state of carbonate; it also contains about one seventy-fifth of magnesia. In some rare instances however, the quantity of magnesia is as much as five per cent. Phosphate of lime is present also in some deposits, in others there is a mere trace, and frequently it is entirely absent. In some marls a small quantity of lime is present as sulphate.

The quantity of magnesia is not estimated separately from the lime in any of the marls, unless it forms at least two per cent. It is enough to say in this place, that they differ very much in different localities, both as regards appearance, the state of division of the shells, and the quantity of lime which they contain. Sometimes the shells are almost as perfect when first exposed as those in the recent state; some crumble into fine powder on exposure to the atmosphere, whilst others remain sound for a long period of time; some have the appearance of dirty lime, scarcely a vestige of shell being visible; others are consolidated like mortar, and have to be dug with pickaxes, often coming up in large, hard lumps, which gradually fall to pieces on exposure to the air. Other specimens, again, have a brick red color, and

are very hard, obtaining both their color and consistency from agglutination, caused by the per oxide of iron. They vary as much in their agricultural value as in their appearance, some containing as little as ten per cent. of carbonate of lime, with only a trace of magnesia and none of the phosphates, others having as much as seventy-six per cent. of the carbonate of lime, and others two and one-fifth per cent. of the phosphates. The *appearance* of the marl is a very *imperfect* indication of its value. Some in which there is but a mere visible appearance of shells, yields as much as fifty per cent. of air-slaked lime, whilst others, which *appear* to be made up entirely of shells, have not more than twenty or twenty-five per cent. In the one case the shells have become disintegrated by heat and moisture, no current of water passing through them during the process; in the other, water charged with carbonic acid has circulated through the shell beds, dissolving and carrying away the lime, the *essence* of the shell, and has left only its form unbroken. As a general rule, those shells imbedded in clay, or which have a large admixture of it, contain more lime than those which have a sandy foundation, as water percolates easily through sand, carrying with it some of the lime by mere force of attrition, and dissolving more when charged with carbonic acid. Water charged with this gas very readily dissolves lime in the state in which it exists in shells. In many beds of marl the *form* of the shell only is left, all of the lime having been dissolved by the above process. The lime in marl is as good, pound for pound, as that which exists in limestones, and has the advantage from its admixture of sand and of clay, of being more easily incorporated with the soil. It is identical with it in every respect, serves the same purposes, answers the same end in the production of vegetation, and should be used to fulfil the same indications, viz: to supply lime to a soil deficient in it. Its application then resolves itself into a mere question of cost. The per centage of lime in a marl being known, its owner can determine for himself whether he can, by using marl, apply to his soil any given number of bushels of lime cheaper than he can by buying lime. An allowance must be made in the marl for the application of a larger quantity of lime than is represented by its analysis, as all of the lime in it cannot at once be made available, in consequence of some of the shells not being entirely reduced to powder. In making this comparison, however, it must be understood that the agricultural lime seldom contains more than eighty-five per cent. of lime. Another item in this comparison is, the greater facility with which lime in marl admits of thorough incorporation with the soil. The inert lime for the present in marl varies in every specimen, and depends on the quantity of large shells which are found in it, and the facility with which they fall to pieces when exposed to the atmosphere. These are then the four sources from which lime is de-

rived for agricultural purposes, viz: limestone, Indian shell banks, burnt oyster shells and shell marl. The indications for its use are its absence or deficiency in the soil and its chemical condition.

MODE OF APPLICATION.

This is a subject upon which there is much difference of opinion among practical men.

The greatest good is obtained from lime when thoroughly mixed and incorporated with the soil. In the application of lime, then, the first consideration should be so to use it as to mix it intimately with the soil. This is sought to be done in three ways:—1st. By applying it to the surface, and suffering it to remain undisturbed for a year or two;—2d. By applying it to the surface, ploughing it under immediately, and working the land in some crop;—3d. By mixing it in compost beds, and applying it in the same manner. Each of these methods has its peculiar advantages, and is also liable to objections. The *texture* of the soil is to be taken into consideration. By the first method, the lime becomes very thoroughly mixed with the soil, particularly if it be a loose sandy soil, as the rain water washes down its particles, and fixes them between the grains of sand. But when lime, or any other manure, is purchased, an immediate return is desired, which cannot be had if this plan be followed. Many of our farmers, too, having but little ready money, cannot afford to spend it without getting a speedy remuneration for its use. By the second method, the lime is thrown to the bottom of the furrow, and cannot be afterwards well incorporated with the soil, which is a great objection, as the benefit from its use, to the fullest extent, is not speedily obtained. The third method has the advantage of diffusing the lime very equally over the surface, insuring its mixture afterwards; but it involves great labor in hauling and applying it, and but a small quantity can be applied at a time in this manner. The best mode of combining the advantages of these several methods, is first to fallow up the ground, which leaves it uneven, with numerous fissures produced by the ploughing, apply the lime, then follow it with a heavy iron tooth harrow, and cultivate it in some crop that requires frequent working,—corn for example. In this manner we mix the lime well with the soil, receive its benefits immediately in a crop, which can be more completely realized, as the corn can be followed by wheat, with which clover may be sown. The chief indications are then fulfilled. 1st. The lime is more thoroughly mixed with the soil. 2d. Return for its cost in a crop of corn. 3d. Increased return by a crop of wheat immediately succeeding the corn, and then the benefit of a good crop of clover, so useful, not only as food for stock, but also as an improvement to the crop which it precedes.

For the reasons above stated, this mode of applying lime is preferable to all others. By it we mix the lime thoroughly with the soil, and obtain immediate return for its cost, a consideration of the highest importance with farmers, who have not the ability to lay out of the profits of their money for several successive years, but need an immediate return. Again this mode gives not only the speediest reward, but gives a much greater profit than any other mode in the same number of years, which is the ultimate end of the application of all manures.

It has been a much mooted question, whether lime should be applied in its *caustic* or slaked state. Pure limes, i. e. those which are not magnesian limes, should be applied, if possible, in their caustic state. We save by this nearly fifty per cent. in the hauling, always a large item in the application of lime; but great as this is, it is not the chief reason. I have spoken of the necessity of the perfect solubility of manures before they can enter into the structure of plants. A soil sometimes may contain all the necessary constituents, but not in a form capable of assimilation. The application of quick lime to soils sets free and renders soluble all the necessary constituents. Chemists frequently avail themselves of this power of quick lime in rendering soluble substances, which otherwise would take a very long time to dissolve. In the laboratory this effect is aided by heat, and takes place immediately; the same effect takes place more slowly in soils, but with equal certainty, without heat.

Some clays have all of the necessary constituents in good proportions, but these are held together so firmly by their affinities that plants cannot obtain enough for their support. The addition of quick lime disturbs their affinities, sets the different substances free, so that plants thrive and grow on land which before scarcely produced any thing.

Quick lime also decomposes the organic (vegetable) matter in a soil giving salts to the nourishment of crops.

Every soil should be *thoroughly drained* before lime or any other manure is applied to it.

Lime should always be applied to the soil in as dry a condition as possible, for when it is wet it becomes cemented into lumps which become very hard, and a long time elapses before they are broken down and mixed with the soil. While it remains in lumps it is of no use to the crops, and those who apply it in this condition not only lose actually the lime, but also its effect on their crops; each a matter of great consideration. Magnesian limes should not be spread on the lands until the lime in them becomes slakened. If put on in the caustic state, water will cause the magnesia and lime to form a cement, and small balls will be formed which require a long time to fall to pieces. There is a custom prevalent in some sections of the State, of mixing caustic lime

with stable and barn yard manure. This cannot be too strongly reprobated. If those who use it in this way were to try to injure their manure as much as possible, they could not adopt a better plan. Ammonia, one of the most valuable constituents of stable and barn yard manure, is expelled from the heap by caustic lime, and escapes into the air.

This plan should therefore *never* be followed. It is no proof in its favor, that the manure, after being treated in this manner, still does good, a part of its valuable constituents, fire will not destroy; but one of the things which give it its peculiar distinctive value, is entirely dissipated when mixed with either caustic lime, (oxide of calcium,) or water slaked-lime, (hydrate of lime.) It is indeed one of the means by which chemists determine the quantity of ammonia in a compound, so thoroughly and entirely does it drive it all away.

Upon grass lands, when they fail to produce well, and that failure is owing to deficiency of lime in them, it may with great advantage be spread on the surface, and have a light harrow run over it.

This will not only insure to the crop the full benefit of the lime, but will materially improve the texture of the soil by loosening the surface, which from the long absence of cultivation becomes *bound*, and frequently covered with moss, and unfitted to produce a good crop of hay. The full benefit of the lime can be obtained without the trouble and expense of breaking the land from its "setting" in grass, and no intermission need be had in the crop. When it is intended to supply the deficiency of lime in a soil by the medium of marl, it should always be applied *as long a time as possible* before the culture of the soil. Atmospheric influences, the alternation of heat and cold, and of dryness and moisture, are all powerful agents to disintegrate the marl, reduce the shells to powder, and bring them into a condition most favorable to the crop whose production it is intended to assist. Situated as the great mass of our farmers are, precise and exact rules cannot be followed. Many are obliged to yield to circumstances, but they should keep the above principles steadily in view, and conform to them as nearly as possible.

They are the result of much and careful observation; are substantiated by the highest authorities; and are derived from a knowledge of the qualities of the cause, by whose application the desired effect is sought to be produced; in other words, from a knowlege of the action of the agent, and the object upon which it acts.

From a knowledge of the properties of lime as carbonate, and of those agents to which it is subject, the reasons for the above rules will appear manifest. I need not here repeat what was said in relation to the *different* modes of applying lime, except in relation to its use as a top dressing for grass. Keeping in view

the great principle of incorporating it thoroughly with the soil, we see how this is done by the top dressing of grass land. Though lime be but sparingly soluble in pure water, yet we have seen that it is quite freely so in water charged with carbonic acid: when marl lies with the decayed leaves and stalks of grass on the surface of the meadow, this gas surcharges rain water, as soon as it falls, *dissolves* the lime, and carries it in a state of solution in the soil.

This is not the only way however in which it is mixed with the soil. A large quantity of lime, though not dissolved, is yet carried down the interstices of the soil mechanically, by the water which falls on it. In this way much of it will disappear from the surface, having become diffused through the soil.

The rationale of the application of marl to the surface is equally sustained, when we consider its physical condition in connection with its chemical qualities.

The lime which exists in marl is always in the state of carbonate, and hence subject to the same influences as common lime that has been burnt from shells or limestone, and become slakened.

There is however this difference, that the lime in marls is either in masses of comminuted shells, or in large fragments that have never been disintegrated. By atmospheric exposure on the surface they are subject to the action of water charged with carbonic acid.

The shells by alternate freezing and thawing crumble into finer particles, become more easily acted on by water impregnated with carbonic acid as this change progresses, and become entirely blended with the soil, fulfilling, perfectly, all the indications which first directed their use.

Under this head we will also speak of

MAGNESIA.

It is the oxide or rust of a metal called magnesium, and its necessity to fertile soils is supported by facts as well established, evidence as conclusive, and testimony as convincing, as those which show the use of lime, potash, or any other constituent.

Like lime, it loses its carbonic acid when exposed to a high degree of heat, and becomes caustic or *calcined* magnesia. It remains in this condition much longer than lime, as it imbibes carbonic acid with much more difficulty from the atmosphere. It also unites to water, but with much less intensity than lime, producing but a very slight degree of heat, whilst the union is being accomplished. Magnesia, for agricultural purposes, is obtained from a rock called dolomite, and is found associated with lime, both existing in the state of carbonate.

The proportion of lime and magnesia in this rock varies in the different localities, and even in different parts of the same rock; and the ratio of their ingredients is very variable, "since its omorphous substances crystallize together in all proportions." We can

only estimate the quantity of each, and the particular adaptation of a limestone to the soil by a quantitative chemical analysis.

The belief is very generally diffused that magnesia, instead of being a necessary constituent of a fertile soil, and an essential part of the composition of plants, injures the quality of the one, and proves detrimental to the growth of the other.

To correct this erroneous impression as far as I can, and show how far it is useful, and when it may be injurious, when it should be applied, and when withheld from a soil, I will briefly review the arguments against its use, and let the facts which I shall offer, urge its application.

Sprengle says that soils containing much of the carbonate of magnesia are said to be highly absorbent of moisture, and to this cause is ascribed the coldness of such soils. This absorbent property of magnesia, so far from being an objection to, is sometimes recommendation for its use, as we find many soils deficient in this property, being light, loose and porous,—deficient in the two great *absorbers* of food from the atmosphere, clay and the peroxide of iron, and not having a sufficiency of fine sand to effect the vicarious action of these substances. Here then, for its mechanical agency alone, magnesia is indicated, and if it had no other use, should be applied.

Chaptal says that "magnesian soils are by no means fertile," and that whenever lime, containing magnesia, is used for agricultural purposes, it no longer produces the same effect."

Against this sweeping declaration of the poverty of magnesian soils, no better argument can be used than that of showing the composition of some fertile soils.

Johnson, J. F. W., Lectures on the Application of Chemistry and Geology to Agriculture, p. 284, "gives a soil which had been cropped for 100 years successively, without manure or naked fallow," containing 1.16 per cent of magnesia, equal to about 350 bushels of magnesia to the acre, to the depth of twelve inches; another containing 3.12 per cent. of magnesia, equal to about 94 bushels, "a virgin soil celebrated for its fertility;" another containing of carbonate of magnesia, 10.36 per cent., equal to about 3,100 bushels of carbonate of magnesia, which had been "unmanured for twelve years, and during the last nine, had been cropped with beans, barley, potatoes, winter barley and red clover—clover, winter barley, wheat, oats, naked fallow."

Analyses of Sprengle, too, show very fertile soils containing—

.06	of	one per	cent	of	carbonate	magnesia.
1.64	"	"	"	of	"	"
.52	"	"	"	of	"	"
2.22	"	"	"	of	"	"
.84	"	"	"	of	"	"
1.04	"	"	"	of	"	"

I have lately examined a soil from the Nile, famous for production from the earliest period of history to the present time, which contained 1.02, more than one per cent., 300 bushels of pure magnesia; one from the rich bottom land of Illinois, containing .51, more than one-half per cent., equal to about 150 bushels of pure magnesia. One from the best South River soil, in A. A. county, containing 120 bushels of air-slaked magnesia, and many others from our own State, very productive and containing from 60 to 100 bushels of magnesia.

The following analyses, also show that magnesian soils, so far from being barren and unproductive, are exceedingly fertile. No. 1. Soil from Kent county, producing 20 bushels of wheat, and 10 barrels of corn per acre, contains of magnesia .35 of one per cent., equal to 100 bushels. No. 2. Also from Kent county, producing 22½ bushels of wheat, 8 barrels of corn, and fine crops of clover, contains .27, equal to eighty bushels to the acre. No. 3. A soil from Queen Anne's county, producing 30 or 35 bushels of wheat, 12 barrels of corn, and fine clover, contains of magnesia .4 per cent., equal to 120 bushels. No. 4. Soil from Queen Anne's county, producing 30 or 35 bushels of wheat, 12 or 15 barrels of corn, fine clover, contains of magnesia .38 per cent.

There is another soil from the same neighborhood, favorably situated, and in a fine state of cultivation, (Dr. W. H. DeC.,) having very nearly the same constituents as the two last mentioned, which produced only 20 or 25 bushels of wheat, and contains only .01 per cent., equal to about 3 bushels of magnesia.

Since my last report this gentleman has applied magnesian lime, with what result the following clear and intelligent letter will show. I give it not only in proof of what I have advanced, but because it describes in a clear and perspicuous manner, the proper mode of application of this lime, and many other facts which will amply repay an attentive perusal.

Cheston, March 20th, 1851.

My Dear Sir:—I now take pleasure in complying with the promise made some time ago, to give you a more detailed statement of the result of the application of the Schuylkill lime to my lands.

You will recollect that on analyzing specimens of soil, you detected a deficiency of magnesia and the phosphates, and suggested to me the propriety of using the Schuylkill lime to supply, in part, the former, in preference to that commonly called Baltimore county, which had previously been exclusively used. Having confidence in the application of the principles of science as aids to agriculture, I at once adopted your suggestion, not merely by way of experiment, for in that case it would have been more carefully and nicely conducted, and not so much entrusted to the "unskillful

manipulations" of careless cartmen, as I was compelled to do when applying it to nearly seventy acres.

The most remote field from the barn yard, and long considered the poorest on the farm, coming into corn cultivation last spring, I was anxious to bring it up to an equality with the others. It had also been hardly treated of late years, having had two crops of corn and one of oats in succession taken from it, with the hope of destroying the running brier, with which it was much infested. I procured 1500 bushels of unslaked Schuylkill lime, delivered to me at a cost of 17 cents per bushel. It came from the vessel in large rough looking lumps of stone, and I had great fears that it would not slake thoroughly; however, two hands were kept diligently at work in pouring water on it from the river, and it slaked beautifully. I am now satisfied that it slaked more than two for one, and that from my purchase of 1500, I obtained in the neighborhood of 3500 bushels of slaked lime. It spread remarkably well, being better pulverized and less sticky than any other lime I have handled. In consequence of the backwardness of the spring, and the late period at which I received the lime, I was unable to conduct its application with all the accuracy and care I desired. The field, of about 70 acres, having been flushed to the depth of from six to eight inches, a few acres were measured and staked off, and the quantity of lime contained in an ordinary cart-load was also measured. It was then regularly and evenly spread from the cart, at the rate of 50 bushels to the acre. After the spreaders had got their "hands in" in this way, it was continued over the remainder of the field as nearly as possible at the same rate; but having the eye as the only guide, it was not, of course, applied with the same exactness as in the commencement. It was incorporated with the soil in the process of harrowing, prior to planting, and by the subsequent cultivations of the crop.

The greatest product of this field, within my recollection, under the most favorable circumstances, was but little over 600 bbls. Now, although the last corn crop on this, can scarcely be considered more than two thirds of an average crop, so far as I can learn, I have the pleasure to inform you that my field yielded seven hundred and eighty barrels *(at least 150 more than it ever before produced,)* this too, without the aid of other manures, very little having been applied in consequence of my intention to lime the land; and in spite of a severe storm about the middle of July, which broke off a great number of stalks, and so completely prostrated many others that they failed to yield. I forgot to mention that on some six or seven acres of this field, Baltimore county lime was applied in the same manner as the other, but by the neglect of my overseer, the precautions which I directed, were not observed, and no accurate comparison could be made in the

result. The corn appeared to me not so heavily eared as where the Schuylkill lime was applied.

I am happy to be able to communicate to you the success of your predictions, so far as your suggestions have been pursued, although in rather a rough and unskillful manner.

I have great faith when the phosphates are supplied in the requisite quantities, that your prophecies of increased product will be "fulfilled to the end."

You will also again accept my thanks for having pointed out to me the means of "renovating" my "worn out field."

Respectfully yours,

WM. HENRY DECOURCY.

Dr. James Higgins, Baltimore.

I have also found soils from many parts of the State very productive, yet containing a large proportion of magnesia; and in many parts of the state we have soils deficient in magnesia, all things else being present, and yet not so productive as where magnesia exists. But the evidence does not stop here, the ashes of the grain of wheat contain from 12.98 to 16.26 per cent. of magnesia, according to the analyses of Bichon, Thou, Boussingault, Wills, and Fresenius; the inorganic part of the grain of barley contains of magnesia 10.2 per cent. Corn, oats and other crops also contain large quantities. These facts show the necessity of magnesia, as strongly as facts can show any thing.

But why multiply proofs? The above are sufficient to show that it is one of the necessary constituents of plants, and of fertile soils, and if it does not exist in a soil, common sense tells us that it must be supplied, or that the soil cannot reach its maximum of productiveness. The application of too much caustic magnesia to a soil, may prove injurious from its caustic properties, since it does not readily imbibe carbonic acid from the atmosphere, and become *mild*, as lime does. But from this property, that of remaining a longer time in the quick state than lime, it exerts a greater and more permanent influence in disintegrating the soil and rendering soluble its dormant constituents.

On the soils not containing a large quantity of vegetable matter, from twenty to forty bushels of magnesia or lime to the acre, is the best quantity. This quantity should be applied every three or four years, until about two hundred bushels shall have been used. The larger the per centage of magnesia in the lime, the smaller the quantity to be used.

The proper quantity of lime per acre is a question, the solution of which is attended with great interest. To arrive at as correct conclusions as possible, I have examined very many productive

soils, and if their fertility depended solely on lime, if it was the only element to enter into the calculation, we might very readily solve the question. But the fertility of a soil does not depend upon the quantity of any one constituent, but upon the proper proportion of them, and also upon the mechanical texture of the soil. To arrive at conclusions, then, we must not only have examined very many different soils of known fertility, but also be cognizant of the action of different quantities of lime upon soils of known composition. From all of the examinations and practical observations which I have made, I do not believe that a greater quantity than seven-tenths of one per cent. is ever necessary in the soil. I now speak of this quantity as obtained by the usual mode of analysis of soil, by their solution in muriatic acid. Soils having this amount naturally, are not improved to the amount of its cost by lime, and after two hundred bushels have been applied, any additional quantity does not compensate for the trouble and expense of its application. I have been frequently asked whether it be best to apply all the desirable quantity of lime at once, or the same quantity in divided doses. The proper solution of this question depends on the ability of the farmer; that course should be always followed which, with the smallest outlay, will give the greatest return, and I would advise all who cannot apply the necessary quantity of lime to all of the soil which may need it, to apply from twenty to forty bushels per acre, and repeat this for every rotation until about two hundred bushels be applied. The profits of a small quantity of lime extended over a large surface will be greater than a large quantity applied over a small surface.

GUANO.

The spirit of progress, lately manifest in political science and in most of the useful arts, has extended to agriculture, and it has sought not only for correct theories, but improved instruments of culture, and new manures to aid it in its operations and perfect its results. There is every year heralded forth to the tiller of the soil some panacea to enrich him, but experiment and science sweep away the baubles when worthless, and in many instances, however, to make way for others, with as little or less merit, and as little deserving public attention or public patronage as those which preceded them.

Guano, however, has had a more enduring foundation, being of real value, a value sustained by scientific investigation, and proved by the sure test of experience. Guano has, does, and will continue to be worth its transportation through a long and dangerous voyage, securing for itself extensive use in our country, and giving in return abundant profit. This manure is one very familiar to our citizens, and one whose history, composition, and best modes of use I design to point out as fully as I can, and at the same time, by facts and common sense arguments based on them,

to induce your honorable body to take steps for the proper inspection of an article varied in its composition, and valuable or otherwise according to the quantity of the several constituents upon which that value depends. The quantity of these constituents, moreover, the seller as a general rule does not know, and the purchaser cannot find out.

In the present article I shall avail myself of all the information which I can derive from reliable sources, being desirous of throwing as much light as possible on this interesting subject. I with great pleasure here make my acknowledgments to the celebrated Dr. Ure, F. R. S., of London, to whose pamphlet I have had access through the kindness of a friend, and to Prof. Way, Chemist, of the Royal Agricultural Society, who has published a very able and elaborate paper on the composition and money value of different specimens of guano, in the 10th volume of the Journal of the Royal Agricultural Society. I refer to this paper with the more pleasure as it confirms all the material points urged by me in my last report, and confirms, also, the necessity for the action which I then urged on your honorable body.

Guano has within the last few years, instead of being a mere object of scientific curiosity, become a great object of commercial enterprise, and of great interest to the agricultural community. Guano in the original language of Peru signifies dung, a word spelt by the Spaniards, huano. It has been employed in Peru from the remotest ages and given fertility to the barren sands along its coast. Hence the Peruvian proverb—"Huano, though no Saint, works many miracles." Severe penal laws protected the birds which deposited this manure during the government of the native Incas. Death was the penalty for landing on the Guano islands when the birds were breeding, and the same punishment was inflicted on those who might kill one at any time. Overseers were appointed to particular districts to see fair play in the distribution of this precious manure.

Baron Von Humboldt thus speaks of it in 1804: "The guano is deposited in layers of 50 or 60 feet thick upon the granite of many of the South Sea islands off the coast of Peru. During 300 years, the coast birds have deposited guano only a few lines in thickness. This shows how great must have been the numbers of birds and how long the time necessary to form the present beds. The strata have undergone many changes according to the length of time they have been deposited. *Here and there they are covered with silicious sand** and have thus been protected from the influence of the weather, but in other places they have lain open to the influence of the air, light and water, which have produced important changes upon them."

* How does this agree with the oft repeated statements of interested individuals who say it is all alike?

The best Peruvian Guano comes from the Chincha islands, which are three in number, and lie in one line from north to south about a half mile apart. Each island is from five to six miles in circumference. consisting of granite covered with guano, in some places to the height of 200 feet in successive strata, each stratum being from three to ten inches in thickness, varying in color from a light to a dark brown. No *earthy matter whatever is mixed with this vast mass of excrement.* At the point where the guano is now worked the height of the deposit is upwards of 80 feet, and the removal of 200,000 tons has scarcely affected it in a sensible degree. As may be imagined from the immense weight of the mass and the gradual way in which it has been formed, its solidity is very considerable, and in some cases it has been necessary to blast it as we would a rock of sand-stone or lime-stone. It is very obvious that in this case the guano will be preserved in great purity, and that we have enough there to last for all the purposes of Agriculture for many centuries yet to come. There is another variety of guano of which only a few cargoes have gone to England, and none of which have come to this country, called Anga mos guano, better somewhat than the Peruvian.

Guano is also brought from Ichaboe, from the Coast of Patagonia, from Saldanha Bay, and lately from Mexico. I have been informed that near Key West, and in several other places on the coast bordering on the Gulf of Mexico, large deposits of this manure abound. It would be well worth the attention of some of our enterprising merchants to examine into this, and our naval officers too on duty there would confer a great favor on their country were they to examine and bring to light these deposits. The composition of such of these Guanos as are sold, I shall show and their differences. Amongst what are called concentrated manures, Guano, without competition, holds the first place. Practical experience for ages in uncivilized countries bears testimony to its value. *Practice and science alike confirm that testimony in the latest times and in the most civilized nations.*

To what, then, does Guano owe its confessed superiority? To what its high rank above other manures? What is that in it which makes it equally sought after by the savage on the wild coast of Peru, the nobility of England, and the lord of the soil in the United States?

I do not pretend to assume the position of a discoverer in answering these questions. I only assume it as a part of my official duty, in giving answer to the above questions, to make public what is known of this article; so that the Agriculturists may have facts placed before them in relation to it, and may thus form opinions fixed on a reliable basis. Very many elaborate analyses of Guano have been published by scientific men, and much light shed on its composition. Unfortunately, however, for practical

men, these analyses are so elaborate, so complex, and clothed in terms so unknown to the mass of those who use it, as to be to them of but little value. Take, for instance, the following analysis of a sample furnished by Humboldt and analyzed by Fourcroy and Vauquelin.

Urate of Ammonia..........................	9.0
Oxalate of Ammonia........................	10.6
Oxalate of Lime...........................	7.0
Phosphate of Ammonia......................	6.0
Phosphate of Ammonia and Magnesia.........	2 6
Sulphate of Potash........................	5.5
Sulphate of Soda..........................	3.3
Sal Ammoniac..............................	4.2
Phosphate of Lime.........................	14.3
Clay and Sand.............................	4.7
Water and Organic matters.................	32.3

Here is an analysis, doubtless perfectly correct, but of what value is its complexity in an Agricultural point of view. Here are words which many intelligent men have never seen before, and which they can find in no dictionary.

Again: Some analyses which have been published combine together several different substances of different values, and thus no one can tell from them the precise composition of the article, nor how much it is worth. Thus we have, for instance, 10 per cent. "organic matter and salts of ammonia," without specifying how much is organic matter, how much salts of ammonia, and what salts of ammonia they are. The different acids unite with different proportions of ammonia to form salts, and we cannot know how much ammonia is present unless the particular salts be separately specified, although ammonia is, as I shall hereafter show, the chief valuable constituent in Peruvian Guano. To obviate these objections, and to place in a clear light the agricultural value of Guano, I have always made analyses to show the value, in an agricultural point of view, of the different specimens, by showing the quantity of the several valuable constituents—those things to which Guano owes its value, for we all know that it is due not to its name, nor to any hidden or mystical quality in it, but to those substances which plants require for food, and which must be present in soils before they can be productive. These are—

First—Ammonia.

Secondly—Phosphates, (combinations of phosphoric acid, with lime, magnesia, potash or soda.)

To these, principally to the first, almost entirely to the two, does Guano owe its value, and we can assign a money value to each, and thus estimate the value of any particular quantity by the aggregate value of the different substances which make up that

quantity. The value of the whole being equal to the united value of the several parts necessary to make up that whole.

There are several other constituents in Guano besides those first mentioned—a little plaster of Paris, a smaller quantity of common salt, &c., but these are in such small quantities as not to be worthy of consideration, because they can be very easily supplied from many sources. The statements which I made upon this subject when last addressing your honorable body I still adhere to, for they have been since confirmed by repeated observation, by the concurrent testimony of many practical men, and borne out by other high authorities than those given at that time. I then said:

"Notwithstanding the various compounds which enter into its composition, yet its value almost entirely depends on two of them. On the ammonia already present in it as a salt, with that which is capable of being formed by the decomposition of its azotized matter, and on its phosphoric acid or phosphates, which are combinations of this acid with some base. The small quantity of the other substances in it possess no particular value, as they can, if needed, be supplied much cheaper from other sources.

Does the value of guano depend on its ammonia which it already may have, or which may be formed in it, and its phosphoric acid or phosphates? We have, in support of this, a unity of sentiment amongst the ablest chemists. Liebig, Ure, Johnston, and indeed nearly all who have written on the subject, agree in the opinion that guano owes its value to its ammonia and phosphates. These two substances *must* give guano its value, or nothing else does, for, take away these two, and only a moiety of other matters remains, which can be cheaply obtained from many sources.

Not only are these substances the cause of the value of guano, but as either may exist in greater or less proportion, in any particular specimen, it makes that specimen better or worse for particular soils. Ammonia is supplied to plants in large quantities from the atmosphere, being absorbed by soils, and, with iron and clay, forms "true salts." But if any particular soil has not this absorbent capacity, and has a deficiency of iron and clay, it cannot obtain ammonia from the usual source of supply, and will be unproductive, unless it be supplied from some other source. If guano is used, then, the purchaser should know which of the different lots contains the most ammonia. But many soils have the capacity to supply themselves with ammonia, but are deficient in phosphates, and therefore barren, and if the owners of soils find it more convenient to buy guano than any other manure, they should know what specimen contains the largest quantity of phosphates, what samples contain the most of what they want. If the purchaser does not know, would he not be constantly liable to loss in buying the wrong specimen? If it even acts well, he is not assured that another specimen would not have acted better. If, on

his land, in one year, he makes a luxuriant crop, by the use of guano, the next year by the use of a different specimen, even at the *same price*, he may make a very inferior crop. Guano, therefore, has a relative value in relation to particular soils, as it can supply them with a greater or less proportion of their deficiencies; it has an absolute value depending on the quantity of ammonia which is already, or can be formed in it, and on its phosphates. Most clearly and unquestionably, then, its inspection should show the proportion of each of these constituents, so as to show its absolute worth, and its relative value to different soils. When a farmer is buying guano, let him know how much of each valuable substance he may be purchasing, then he will not be spending his money without knowing what he is getting for it, and can better suit his guano to his particular soil. The proportion of the two valuable substances is very variable, and yet the guano, at present, has but two, or, at most, three grades of value.

To show the quantity of valuable matter which we have a right to expect in genuine Peruvian Guano, I here annex the analysis of eight specimens of Guano made by Way, of London, whose skill and accuracy as an analyst has been endorsed by the highest chemical authority in Europe, Baron Liebig.

Peruvian Guano imported in 1847—8.

Number of Specimen,	1	2	3	4	5	6	7	8
Name of Ship, . .	"Agamemnon."	"General Alaix."	"Manchester."	"Queen of the Isles."	"Director."	"Othello."	"Parkfield."	"Osprey."
Water, ...	16.16	17.29	8.88	22.68	17.95	16.72	12.57	15.85
Organic Matter and Salts of Ammonia,	57.13	50.66	58.82	44.19	51.39	51.35	37.78	55.28
Sand, ...	1.17	1.64	1.36	1.22	1.34	1.58	1 72	1.23
Earthy Phosphates,	19.46	23.07	25.27	28.83	20.98	29.74	34.45	20.30
Alkaline Salts, . .	6.08	7.34	5.67	3.08	8.34	.61	13.48	7.34
	100 00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Ammonia supplied by 100 parts of each specimen,	18.94	17.46	17.86	16.83	18.01	16.40	18.50	16.92

These show what genuine Peruvian Guano *ought* to be. How far they correspond with what has been sold in our market, let a comparison with those which I shall hereafter give show. I now give three others from the same authority, of which he says:—"The next analyses are samples of those sold to different persons as genuine Peruvian Guano, but which are so low in ammoniacal composition as to lead to a doubt of their genuineness.

Inferior Guanos.

Number of Specimen,	21	22	23
Water,	19.74	11.29	11.22
Organic Matter and Salts of Ammonia,	46.17	46.45	34.68
Sand,	2.46	2.63	5.44
Earthy Phosphates,	31.59	26.71	21.09
Alkaline Salts,	.04	12.92	25.71
	100.00	100.00	100.00
Ammonia yielded by 100 parts,	11.89	10.41	8.12*

"The large quantity of alkaline salts in the third specimen is due to the presence of a quantity of gypsum and common salt with which the guano has been adulterated, while, at the same time, the proportion of earthy phosphates has been kept up probably by the mixture of a certain quantity of one of the cheaper varieties of guano."

What must be thought now of guano containing 35 per cent. of sand, of those which contain but 4 to 10 per cent. of ammonia, or of that which contains three flour barrels of large pebble stones in a ton? Be they purposely adulterated, which I do not charge, be they impurities natural to it, the phase of the matter is not changed to the purchaser—he should receive an equivalent for his money, that equivalent is not to be found in sand or gravel stones The above analyses from samples taken with the greatest care, show what we have a right to expect in No. 1 Peruvian guano. The average of all the analyses made by this gentleman show the average composition of undamaged Peruvian guano to be of

Ammonia	- - - -	17.41	per cent.
Phosphate of Lime	- - -	24.12	" "
Potash	- - - - -	3.50	" "

In England this manure is offered for sale *guaranteed* to contain 16 per cent. of ammonia by the ton of 2240 lbs., at a less rate than it is sold here with no guarantee, for 2000 pounds, because protected (?) by an inspection which allows in some instances 6, 8, 10, 12, 14, 16 and 17 per cent. of ammonia alike to pass as No. 1.

PATAGONIAN GUANO.

This differs from Peruvian guano in the small quantity of ammonia and in the large quantity of phosphates which it contains. This difference is due to the difference in natural causes, existing where the two deposits are made.

On the coast of Peru rain very seldom falls, and the atmosphere

*The result of two analyses closely agreeing.

is almost always very dry. The material which constitutes the chief value of guano is not volatile when existing as deposited by the birds, but only becomes so when it assumes the form of ammonia. This it can only do when subject both to heat and moisture; but little moisture is present on the coast of Peru; decomposition does not take place; no volatile materials are formed, and after ages the guano may remain as when first deposited.

On the coast of Patagonia much rain falls. We have here both causes in action to produce decomposition, and the product of this decomposition, being a volatile substance (ammonia), passes off into the air, leaving the substances which are not volatile, such as phosphate of lime, &c., in greater proportional abundance than they would otherwise be found. The constant tendency of Peruvian guano, when exposed in our climate, is to become similar in composition to Patagonian guano, that is, decomposition will take place in it from the combined agencies of heat and moisture, the valuable volatile materials formed will pass off, and a larger per centage of phosphates, &c., will remain.

These teachings of theory are fully borne out by analysis. We find the quantity of ammonia that already exists, or of materials capable of forming it, in very small quantities; whilst the quantity of fixed materials, such as phosphates, are proportionately larger than in the Peruvian—just as a larger per centage of wheat would exist in a bushel after it was fanned than before that operation took place.

Without giving at full length the analyses made of this substance, I will only state that in 14 specimens of Patagonian Guano, analyzed by Dr. Ure, Teschemacher, and by Way,

The highest per centage of ammonia was -	4.68
The lowest - - - - - -	1.60
The average - - - - - -	2.54

Of phosphate of Lime, omitting one specimen,

The highest per centage was - - -	65.5
The lowest - - - - - -	29.3
The average - - - - - -	44.6

The above analyses, to show the composition of Peruvian and Patagonian guano, were made by disinterested, competent parties in England, and show—first, what the composition of good unadulterated, undamaged Peruvian guano should be—secondly, that although it may fall short of what it should be fifty per cent., analysis is required to show it—thirdly, the great difference between Peruvian and Patagonian guano. These are all important facts, to be borne in mind when we come to speak of the proper inspection and money value of this article.

5

There is another variety of guano lately brought to our market, called

MEXICAN GUANO.

I have not yet examined it myself, but the analyses of it by various distinguished chemists show it to contain from 60 to 61 per cent. of phosphates and between 1 and 2 per cent. of ammonia. It is sold at $25 by the ton of 2240 pounds. It cannot take the place of the Peruvian on those soils to which the Peruvian is especially adapted, which are by far the greatest number, but to soils which can absorb abundance of ammonia from the atmosphere, and are deficient in phosphates, it is the cheapest manure by which this deficiency can be supplied. A ton of 2240 lbs. contains of phosphates about 1366 pounds, at $1\frac{1}{2}$ cents per pound, worth $20.49; of ammonia about 33.6 pounds, worth $4.03—equal to $24.52. The price of $25 per ton of 2240 pounds, certainly is very near its real value. Justice to this guano requires that the other varieties should be correctly inspected.

Guano is a compound of various substances, having different values. A large proportion of one of little worth cannot make up for that which is more valuable—any more than cents can make up for dollars, or pounds of silver make up for pounds of gold. What is the absolute, or what the relative worth of its different valuable constituents? These we have shown to be ammonia or compounds capable of forming it and the phosphates. They are not salt, because that can be more cheaply supplied; they are not sulphates, because they too can be obtained at less cost; it is not organic matter deprived of its ammoniacal elements, because it can be found in any marsh or barn-yard, certainly it is not sand and gravel stones, because these are often-times too abundant on some farms already, and certainly would be *dear* any where, provided we had to pay for them at the rate of $46 or even $38 per ton, as has been the case in some specimens of guano, and for *which privilege the State* compelled the purchaser to pay her a valuable consideration. If the value depends upon none of these, it must depend upon those which are left, that is, its ammonia, phosphates, and perhaps potash, but as to the latter, not to an extent worth estimating in the calculation of values; all these are commercial articles, having known and determined values.

Without going into any elaborate reasoning to show the money value of these several ingredients in guano, I will here state that whether we determine the value of the ammonia by its market price, or whether by what remains after deducting the cost of the other valuable constituents in pure Peruvian guano, 12 cents per pound will be a fair valuation for it. The phosphates present no difficulty. They can be purchased at the rate of $1\frac{1}{2}$ cents per pound.

The small quantity of sulphates are entitled to no consideration. The salts of potash and soda taken together will not be found to be worth, at most, more than one half dollar, if they have any value at all in guano; no one would buy it on account of these salts, none would refuse to buy it if ammonia and phosphates in good proportions were present, and these entirely absent, it is very doubtful, therefore, if they should enter into the calculation. But this does not at all alter that for which I am contending. If the above values of the above substances are all wrong, they have a relative value, and are worth no more in one cargo than in another. Ammonia from the ship Howard is worth no more than ammonia from the Amesbury, the Ellen Barres or the Aballino.

Phosphate of lime is worth no more from the "Ariadne" than from the "Diana;" its value, is not any greater from the Mary Broughton than from the Grace Darling. Since these things then are of the same value in guano, no matter where found, and since they give it its true value, should not the price be in proportion to their quantity? Let a good cargo be worth what it may—that which is only half as good, because containing only half the *quantity* of valuable constituents, should be worth only half as much. Marks of inspection should have some meaning—they should show the value of the article on which they are placed, or they should not be placed on it at all. No. 1 should mean something, not be a representative of \$48½ worth of valuable matter in one instance, as I shall show, and of only \$34 in another instance. For if the Ellen Barres' cargo was worth \$48½, by the same rule which established that value, the Howard was only worth \$33.75. Yet both of these bore the same inspection mark, were sold at the same price, and the State guaranteed them to be of the same value—and for that guarantee exacted from the purchaser forty cents per ton. Forty cents for what? Why, to make him give for the Howard's cargo at the rate of \$46 or \$48 per ton for that which was only worth \$33.75 per ton.

Again, we have an inspection mark No. 2. The usual price for this brand has been from \$36 to \$38 per ton. The Patagonian guano being marked almost always, as I have been informed, by this number—what is its real value? The average of Ammonia is 2.54 per cent.; worth in a ton, say \$6.09. Of Phosphates, 44.60 per cent., worth at most \$13.38. The value of a ton being, say \$19.50. And for this privilege of paying \$36.00 or \$38.00 for that which is only worth \$19.50, the State exacts 40 cents per ton. I care not whether the estimates of the above values be absolutely correct or not, they certainly are relatively so. If the average of good Peruvian guano is worth \$46 per ton, then the average of Patagonian is worth only \$19.50 per ton. Let good Peruvian guano be worth what it may, the average of Patagonian is worth to it in the ratio of \$19.50 to \$46, and no more—

or not half so much. whereas its selling price has been only a difference of from $8 to $10 per ton—it should have been at least $25 per ton. I now speak of the average of what good undamaged unadulterated Peruvian guano should be, such as is carried to the English market, and of what good unadulterated Patagonian guano should be, such as is carried there also—what have we in our markets as "Best No. 1 Peruvian guano," and what are our Patagonian, or No. 2 guanos? The Peruvian bears the same mark, No. 1, the Patagonian also the same mark, No. 2. Are all the Nos. 1 alike? Are they worth the same thing? and are all the specimens marked No. 2 alike? Do they possess the same value? In my last report, pages 72 and 73, I showed the analyses of two cargoes, one of which marked "specimen A," containing of ammonia 4 per cent., phosphates 36 per cent., (according to the rule already given,) worth, say $20.50, another marked "O," containing of ammonia 15.25; phosphates, 46.12, worth by the same rule at least $50 per ton. They were both marked No. 1, were sold at the same price, and were inspected some time in the year 1848. To show the composition of the guano which comes to our market, I here give the analyses of 13 cargoes of Peruvian guano, all marked No. 1, and of 4 cargoes of Patagonian, marked No. 2, furnished me by the present inspector of guano. If it be asked why they were marked alike by him, though so different in composition, so varied in value, I answer, that whilst this energetic and faithful officer fully admitted the correctness of the form of inspection which I have advocated and here advise, yet by the advice of eminent legal counsel, he was constrained to mark it in the "old way." Another proof that the less farmers have to do with law the better, as it seldom benefits *them*.

What those differences in composition are, and what the worth of the several cargoes, let the following analyses show; to which are attached the names of the vessels which brought them. These are the analyses furnished me at my request by the present inspector; to which I have added the money value of each separate valuable constituent, and the value of a ton according to them, from each cargo.

Name of Ship.	Mary Broughton.	John Marshall.	Aballino.	Diana.	Plymouth.	Victor.	Citizen.	Howard.	Amesbury.	Dudley.	Ellen Barres.*	Pocahontas.	George & Henry	African.	Carolina.	Grace Darling.	Ariadne.	Matilda.	Guano from Penguin Island.
Inspection mark,	No. 1	No. 1	No. 1	No. 1	No. 1	No. 1	No. 1	No. 1	No. 1	No. 1	No. 1	No. 1	No. 1		No. 2	No. 2	No. 2	No. 2	
Ammonia, . . .	12.34	16.74	13.24	14.70	13 43	12.73	15.72	11.00	17.00	15 20	17.00	15.20	14.64	1.00	4.20	2.35	4.20	3.46	Ammon. 3.18
Phosphates, . .	23.00	27.08	30.04	28.40	26.60	26.80	24.00	24.05	22.00	24.20	26.00	26.00	25.60	30.00	36.40	36.50	37.04	22.70	Phosph. 25.50
Sand, ...	4.05	1.02	1.04	2.00	1.30	4.05			1.02	1.44	1.04	1.34	4.50	61.09	6.90	7.70	13.02		Gravel, 11.50 Sand, 14.00
Salts of Potash and Soda, ...	7.08	6.05	3.03	7.75	8.40	5.09		7.08	8.75		11.08	8.34							
Money value of Ammonia, . . .	29.61	40.17	31.77	35.28	32.23	30.55	37.72	26.40	40.80	36.48	40.80	36.48	35.13	2.40	10.80	5.64	10.80	8.30	7.63
Money value of Phosphates, .	6.90	8.12	9.12	8.52	7.98	8.04	7.20	7.35	6.60	7.26	7.80	7.80	7.18	9.00	10.92	10.95	11.22	6 81	7.65
Money value of valuable constituents,	36.51	48.29	40.89	43.80	40.20	38.59	44.92	33 75	47.40	43.74	48.60	44.28	42.31	11.40	21.72	16.55	22.02	15 11	15.28

This table shows the composition of some of the guano brought into the port of Baltimore, and sold to our farmers during the past year. In some of the cargoes the ammonia is 17 per cent., in some 14, in others but 11 per cent., *yet marked alike and sold for the same price.*

This is an immense difference; yet the inspection by State authority shows them to be the same. Whatever the value of a first rate cargo may be, it should not be equaled by one 25 per cent. less valuable. The best, at its present price of selling, is high enough to remunerate the importer; the worst certainly does not, in its results, reimburse the purchaser. The difference between different cargoes of No. 1 is very great; but how is it between No. 1 and No. 2? The former generally sell at from $46 to $48 per ton of 2000 lbs. The latter from $36 to $38 per ton of 2000 lbs. What is their real difference? If No. 1 of average composition is worth $46 per ton, No. 2, of average composition is not worth more than twenty dollars per ton, estimating the value of the same constituents in each by the same rule. Put what price you please upon the several valuable constituents in No. 1, and put the same price upon the same articles in No. 2, and you have the above difference; and certainly a substance is worth no more in the one than in the other.

I have shown the intrinsic value of guano to consist in its ammonia and phospates; and inasmuch as the average of the Patagonian only contains from 2.5 to 3 per cent. of ammonia, and not enough of phosphates to make up the deficiency, to make it worth its present market price we must assume its valuable constituents to be worth double as much as the same are in Peruvian guano.

But it is obvious a pound of ammonia or of phosphates in Patagonian guano is worth no more than a pound in Peruvian guano. By the above facts I have shown the difference in different cargoes of Peruvian guano No. 1, and also in Patagonian guano No. 2. I have, moreover, shown that the real difference between No. 1 and No. 2 is much greater than the difference in their price, as sold in our markets. Your honorable body will recollect that these are analyses furnished me by the State Inspector.

I have not given any of my own, because the above were sufficient and needed no confirmation. If they did, I could show many made by myself, in which the difference is equal, and in some instances much greater between guano bearing the same inspection mark, and selling at the same price. In one cargo which came under my notice, the per centage of sand was 35 per cent., yet it was marked No. 1. It contained but 10 per cent. of ammonia. If guano of this composition does act well, it only proves that 10 per cent. of ammonia will produce a fair crop. It certainly cannot prove that 10 per cent. is equal to 16 or 17 per cent.; of the latter

kind a much less quantity, costing a much less price, would have produced equal results. Let the best guano sell for its value; but an inferior article should never be allowed, under state authority, to be sold for the same price. I know that our farmers and planters do not object to pay for any article its full value; but they do object to pay for any thing more than it is really worth. They do object to pay for any inspection when that inspection is no protection to them; when instead of giving them light, it leads them, by its utter worthlessness, into error. Is there necessity for any inspection? I have before stated that it is the bounden duty of the state to protect its citizens from loss or wrong, whether that wrong be effected by superior force or by superior knowledge. The state has acknowledged this by the appointment of inspectors of many articles in common use; the duty of these being to protect the less skilful in their dealings, by showing the real or relative value of the different articles inspected. The merchant can very easily afford to have his cargo analysed, and thus know its real value; but the purchasers of small quantities of guano cannot do this, because of its expense. The merchant can thus know the value of the article he is selling; this the purchaser cannot know without great inconvenience and expense, and thus the former will always have an advantage over the latter. The state then should show to the latter what is the value of what he is buying, and thus interpose her knowledge to save him from loss. I do not consider it worth your time further to argue this question. The abolition of state inspections elsewhere is well known to have opened the door to immense frauds, and we have no reason to believe that a different result would follow here. Neither shall I pretend to answer the objections which some have urged against this inspection, on account of its alleged impossibility.

Samples can be taken to represent all the different cargoes, or different parts of the same cargo, with as much facility as samples can be taken of any thing else, and when taken they can be accurately estimated, and their true value shown.

Every bushel of wheat is not weighed in order to show its weight, but only a sufficient number fairly to represent a cargo.

In England we have seen that adulterations have taken place of this article, and care should be taken to prevent the possibility of it here. have not yet seen any evidence of adulteration on the part of our guano dealers; but others of less integrity may become dealers, and impose on our citizens if they be not prevented. The differences which exist in guano may depend on the difference in its location; that part exposed to the action of water will be less valuable. We have seen, moreover, that some of the deposits are covered with sand; this cannot be separated conveniently by the vessels whilst loading; but the purchaser here should not pay for it. Whatever may be the cause, whether from

adulteration or from natural causes, the difference in value exists in the article, and that difference should be made known. I am very happy in being able, in addition to other testimony, to adduce that of the celebrated Dr. Hare, "nomen clarum et venerabile." Dr. Hare is one of the very first of living chemists and philosophers. Being entirely disinterested, and fully competent to judge in this matter, his opinion is entitled to the highest confidence.

During the last spring, when public attention was much directed to this subject, in consequence of some analyses of guano which I published in the "Baltimore Sun," a committee of the Elkridge Agricultural Club solicited his opinion, which he gave in the following letter:

PHILADELPHIA, May 13th, 1851.

GENTLEMEN—Mr. R. H. Hare has, in your behalf, requested me to state whether, in my opinion, it can be possible to estimate the comparative value of different specimens of guano without a resort to chemical analysis. I am surprised that there should be any doubt on this subject. The fertilizing power of the manure in question is notoriously dependent upon the proportion of phosphoric and nitrogenous matter (matter capable of forming ammonia) which it contains. To determine the quantities of these ingredients without analysis is utterly impossible.

I refer you to the pamphlet of Dr. Ure on this subject. Dr. Ure justly alleges: "The farmer should never purchase guano, excepting its composition in the preceding particulars be warranted by the analysis of a competent chemist."

This distinguished chemist adds, "In a recent case which came under my cognizance, in consequence of being employed professionally to analyze the identical cargo, I found the guano to be nearly rotten and effete, although," as he adds, "the purchasers bought it under the conviction that it contained 19.4 per cent. of ammonia."

I am of opinion that the person employed to inspect guano ought to be an accomplished chemist, and should be allowed to employ, at the public expense, at least one competent chemical assistant. That every cargo imported should be scrutinized and samples taken of every variety, each of which should be analyzed so as to furnish certificates of them severally, of which the purchasers should be entitled to certified copies.

I am, gentlemen, respectfully yours,

ROBT. HARE.

To Messrs. Glenn and Lurman, as members of a Committee of the Elkridge Agricultural Society.

In proof, then, of the necessity of an inspection; in proof of the manner in which it ought to be performed, to show the quantity of valuable constituents, your honorable body has the highest testimony in England, where guano is used to much greater extent than in this country. You have the authority of the most distinguished chemist and philosopher in this country, and you have proofs from the ascertained composition of the article itself. Some of the largest dealers and most intelligent merchants of Baltimore are favorable to an inspection of the kind which I have advocated, and it is to their interest. They will then pay for the article in proportion to its value, and sell it at a fair price, without any trouble. At present they buy cargoes—sometimes before it arrives, provided it shall be No. 1; but No. 1 materially differs, and thus one merchant may have a cargo very inferior to another, although he paid the same price for it. If analyses of the two cargoes be made and published, the one having the better cargo will sell it much more readily than the one with the inferior cargo. He will thus have an advantage in his sales, to which he is not entitled, by having paid no more than the possessor of an inferior article. But the interest of the consumer especially demands that there should be a proper inspection: its demands—being equal, right and just, doing injury to none—should be granted. Let there be fair play.

To show the loss incurred by the purchaser under the present system, let us take two cargoes, that of the Ellen Barres and Howard. A ton of 2000 lbs. of the Ellen Barres's cargo contains of

Ammonia, 340 lbs., at 12 cents per lb.—worth	\$40.80.
Phosphate of lime, 520 lbs., at 1½ cents per lb.—worth	7.80.
Total,	\$48.60.

A ton of the Howard's cargo contains of

Ammonia, 220 lbs., at 12 cents per lb.—worth	\$26.40.
Phosphates, 490 lbs., at 1½ cents per lb.—worth	7.35.
Total,	\$33.75.

Being a difference of \$14.90 per ton, which, in a cargo of a thousand tons, would be \$14.900, nearly fifteen thousand dollars loss to the purchaser of a single cargo, besides loss of crop, labor, freight, &c. It will be seen that the average of the 13 cargoes of Peruvian guano which I have given is 14.60, and falls below the average in England, by more than 19 per cent., and below the guarantee there by more than 9½ per cent. IT IS TO BE EXPECTED THAT THE WORSE GUANO WILL COME TO OUR MARKET, WHERE IT IS SOLD WITHOUT A GUARANTEE, AND WHERE THE INSPECTION HAS BEEN A MERE FARCE IN EVERY THING, SAVE ITS EXPENSE. It may be said that the guano merchants have a right to ask what they please for their guano, and it rests with the consumer whether to

buy it or not. Guano is an article of commerce, and like all other commercial articles, its price will be in proportion to the demand and supply. The best of it can be furnished here at a good profit, at prices which, at present, an inferior article brings, and whenever profits are to be made, commercial enterprise will avail itself of the opportunity to make them. The purchaser is no more dependent on the seller for his guano, than the former on the latter for his money. *Guano ought to bring a higher price in England than here, for the crop there produced by it is worth more than the same quantity produced here. But it costs less.*

The details of a proper inspection law can be easily made out, and inspections performed with a sufficient degree of practical exactitude. Let there be a standard of ammonia and of phosphates to make No. 1, and whatever else may be under that, let it be marked No. 1, less — per cent. Let the name of the ship be marked on each bag, and compel the seller to have a precise copy of the analysis of whatever guano he may offer for sale, with the name of the ship attached; this copy to bear the certificate of the inspector, and be open to the inspection of every one who may wish to purchase; or whatever may be the details, LET THE PRINCIPLE BE CARRIED OUT, THAT THE INSPECTION SHALL SHOW THE QUANTITY OF VALUABLE MATTER IN THE ARTICLE INSPECTED.

I have dwelt thus long on this subject—its importance to the agricultural interest demanded that it should be fully presented to your notice. I felt it my duty to make the above statement in justice to that interest, and shall offer no other apology.

I have been frequently called upon to make examinations of guano for purchasers, have been written to by many to inform them where the *best* guano was to be had. In obeying these calls and answering these queries, I have been threatened with suits for damages, and attacked in various other ways by interested individuals. These efforts to change my course I did not consider necessary to notice, as it is well known that *no public officer ever discharged his duty without giving offence to those who were interested in the neglect or faithless performance of it;* and I only mention them here to show how deep an interest is felt in preventing the proper understanding of this subject. Until I am especially prevented, by competent authority, I shall, whenever I can, make examinations of all substances without a guarantee, offered for sale as manure, publish the results, and abide the issue.

MODE OF APPLICATION.

Under this head I shall treat not only of the mechanical application of this manure to soils and crops, but also of the previous treatment to which guano should be subjected before its use; and I shall speak of guano not as an element—not as a substance

of unvarying composition, but as it is found, a mixture of several substances, in various proportions, each one having particular uses and particular adaptations. First, of guano having a large quantity of ammonia: *this should be applied to all soils not having the mechanical texture to absorb ammonia from the atmosphere, to all soils which bring poor crops, whether clayey, sandy, or gravelly.* To all crops on poor land, from whatever cause that land be poor, except from deficient drainage. No manure will pay for itself on land which is too wet: both money and labor are thrown away on it. Good Peruvian guano in the above instances will pay well. Especially should it be applied to the wheat crop, taking care to sow the wheat on land which from its texture is adapted to its growth. Always it should be applied to those crops which have the greatest money value.

Custom has generally assigned two hundred pounds as the proper quantity per acre, but I cannot say whether this be the best quantity or not; some have obtained equal results with one hundred pounds. From the varied composition of this manure, reliable data could not be obtained as to the best quantity, as it is plain that 150 pounds of some specimens are as good as 200 pounds of other specimens. Experience heretofore has been but of little use, because the consumer did not know what he was experimenting with. His No. 1, of one cargo or of one season, might be, in many instances, a very different thing from the No. 1, of another. The certainty of agricultural experience, therefore, also demands an inspection to show the quantity of the different valuable constituents in this article.

On lands which will produce from eight to ten bushels of wheat, I would not advise the application of this guano. I do not believe that the increased crop which it will produce on land of this capacity will remunerate for its expense. Other manures of the kind to be determined by analyses should be applied. The advice which I have given is founded on the knowledge of the produce of a very large number of applications of this substance which were made in different years, to different soils, in different parts of the State. After the soil has been put in fine order, it then may be sown broadcast, harrowed, or ploughed in with a light plough. I would not advise its being ploughed in deeply; with corn it has been used in the hill; in this manner it should always be mixed with a little woods earth, or something of that sort. Public attention has lately been directed to the question whether plaster of Paris (gypsum) should be mixed with guano or not. The combinations alleged to take place between the sulphuric acid of the gypsum and the ammonia in the guano have been denied. It will be remembered that sulphate of lime, gypsum, (plaster of Paris,) was recommended to be applied not only to guano, but to stable manure, and all other manures, which by their decomposition pro-

duced ammonia, because of the mutual decomposition of the carbonate of ammonia, the state in which ammonia exists in manures, and of the sulphate of lime, which is plaster of Paris. The results of this mutual decomposition is the production of the carbonate of lime and sulphate of ammonia, thereby producing a fixed, instead of a volatile form of ammonia. In this process the gypsum gives its sulphuric acid to the ammonia, and takes in return the carbonic acid from the ammonia. These changes take place by the laws of affinity, that is, by the sulphuric acid having a greater degree of affinity for ammonia than for lime under particular circumstances. Baron Liebig, many years since, attributed the good effects of plaster on land to its fixing the ammonia of the atmosphere; since then it has been advised by him and many others following him to apply this substance to manures which contained ammonia. His views of the above changes have been denied by very high authority in England,* and the utility of the advice questioned in this country.

The high authority of Baron Liebig with the experiments detailed by him satisfied me of the correctness of his views, and I have always advised for many years past, long before the office which I now hold was created, that plaster should be mixed with guano, scattered on stable and barn-yards, manure-heaps, and whatever excrementitious matter was placed in any quantity; and this I always followed myself with success equal to my expectations.

The confident tone of Mr. Pusey's contradiction led me to the following experiment: it was made with the greatest care, every possible contingency of error being strictly guarded against.

One thousand grains of a sample of guano, containing 15 per cent. of ammonia, was carefully mixed in a mortar with one thousand grains of sulphate of lime (gypsum)—this was then placed in a large flat dish and exposed in a window, being first moistened with five hundred drops of water. This we will call specimen No. 1. One thousand grains of the same guano without any mixture of plaster was moistened with the same quantity of water and placed in a dish by the side of No. 1. This specimen without the plaster or sulphate of lime, we will call No. 2. At the end of three weeks the ammonia in both was estimated.

No. 1 contained of ammonia - - -	142 grains.
No. 2 contained of ammonia - - -	34 grains.

Showing most clearly that the specimen with the plaster had lost only eight grains of ammonia in the 150, whilst that without the plaster had lost 116 grains in the 150. Here were two specimens of the same guano, treated exactly in the same manner with the exception of plaster being added to No. 1—and here

* Hon. Th. Pusey, M. P. Jour. Royal Agr. Soc. Vol. 11, Part II.

is the result; to me, or to any unprejudiced person I should think, conclusive. Mr. P. states, moreover, that the plaster must have 500 parts of water or it will not act—the above shows this quantity to be unnecessary. Baron Liebig,* upon this subject says: "Moreover, it is known to every tyro in Chemistry that thousands of cwts. of sulphate of ammonia have been made by simply bringing powdered gypsum into contact with *carbonate of ammonia*." So confident a statement from so high a source is unquestionable.

I invite all who are competent, and who doubt the above facts, to make the experiment for themselves; it will save a great amount of useless talk and useless writing. If the practice of mixing sulphate of lime with ammoniacal manures is useless, let the fact be proved and the custom abandoned. If on the other hand it preserves their most valuable part from loss, certainly it should be adopted. That it does this, the testimony of the highest authority, as well as the evidence of my own senses prove. I therefore recommend that plaster should always be mixed with guano as soon as the guano is received, and that plaster should be always applied to stables, to barn-yards, to privies, and wherever animal or vegetable matter is undergoing decomposition. Let it be applied to secure the value of the manure, and to preserve the health of the animals in contact with it. The proper quantity to be mixed with guano must next be considered. *This must be in proportion to the quantity of ammonia in the guano.*

Chemical substances always unite in definite proportions. These proportions are called combining numbers. The combining number of ammonia is 17.19, i. e. 17.19 parts of ammonia always combine with a particular number of parts of whatever substance it unites with. The substance in plaster of Paris that unites with ammonia is sulphuric acid, its combining number is 40.10, and in whatever connection it is found, there is always this number of atoms of sulphuric acid; 17.19 parts of ammonia then, always unite to 40.10 parts of sulphuric acid, to make sulphate of ammonia. In order to convert the ten parts of ammonia into sulphate of ammonia, let these parts be grains, ounces, or pounds, it matters not—there is required 23.3 parts of sulphuric acid, and it will require 50.34 parts of pure gypsum to furnish this sulphuric acid, because gypsum, which is really a hydrated sulphate of lime, is composed of

Sulphuric acid, - - - - - - -	40.10—1 equiv.
Lime, - - - - - - - - - - - -	28.50—1 "
Water, - - - - - - - - - - - -	18.00—2 "

And it will therefore take 86.60 parts of gypsum *to fix*—that is, to convert into sulphate, 17.1 parts of ammonia. Take, then, guano

* Familiar Letters, Page 499, London Edition.

of the average composition in our market, say containing 14.50 per cent. of ammonia—that is, fourteen and a half pounds in the hundred; now to fix this quantity of ammonia there will be required 73.04 pounds, say 73 pounds, of pure gypsum, because it will take 73.04 pounds of pure gypsum to furnish 33.08 pounds of sulphuric acid, the quantity necessary to fix or to convert into sulphate of ammonia 14½ pounds of pure ammonia.

It will be seen from the above how important it is for the consumer to know the composition of his guano, in order to mix with it the requisite quantity of plaster to preserve its most valuable constituent, for without a proper material is used and in the proper quantity, loss is always liable to occur. I will add one practical caution here. Gypsum as it is frequently met with in commerce is not perfectly pure. This cannot be expected. It sometimes contains not more than fifty per cent. of pure gypsum; usually, however, the average is about 85 per cent., and therefore larger proportions than those I have mentioned must be used. I therefore advise in practice that an equal quantity of plaster and Peruvian guano be always mixed thoroughly together, as by this means there will be more certainty of having enough to fix all the volatile matter in the guano, the excess of gypsum, to say the least, being worth but little and doing no harm. Guano, when *immediately* applied to *some soils*, does not require any thing to fix it, that being done by the soils themselves; but the purchaser cannot know the soils that will do this, and therefore should always use plaster with his guano.

This mixture should be made as thorough as possible, as thereby the beneficial results will be much more certainly attained. With Patagonian guano a much less quantity of gypsum should be used than with Peruvian, as it contains much less of volatile matter to be fixed. With this variety practically about 20 pounds of gypsum to the 100 of guano will be all that is required. It is more valuable for its phosphates than for its ammonia; but I surely would not advise persons to buy it at its present price of from $36 to $38 per ton. The same amount of valuable matter can be obtained cheaper from other sources. I may here lay down a general practical rule, which is correct enough for all practical purposes, and that is: for each per cent., for every pound of ammonia in the hundred pounds of guano, six pounds of gypsum should be used.

All these facts and experiments show how necessary it is to have an inspection which shall exhibit the quantity of valuable matter in this article. It is necessary in order to protect the purchaser from loss; it is necessary in order to enable him to make experiments for future guidance as to the best quantity to be used; it is necessary in order to enable the purchaser to mix the proper quantity of other material to preserve its value when bought.

In reference to guano I have shown the following facts which should be remembered:

First.—That it is widely different in its composition.

Second.—That this difference exists amongst cargoes coming from the same place, and bearing the same inspection mark.

Third.—That a much greater difference exists between the real value of that called Peruvian and that called Patagonian, than between the prices at which these different varieties are usually sold.

Fourth.—That the value depends almost exclusively upon the quantity of ammonia which already exists in it, together with that capable of being formed by its azotized matter during decomposition, and its phosphate of lime.

Fifth.—That these are worth about as follows: The ammonia about twelve cents per pound, the phosphates about one and a half cents per pound.

Sixth.—That the inspection should show to the purchaser as near as practicable the per centage of these constituents in each cargo.

Seventh.—That the inspection hitherto has failed to do this, and therefore has been useless.

Eighth.—That guano should always be applied to that crop having the greatest money value.

Ninth.—That gypsum, plaster of Paris, should always be thoroughly mixed with it, the best proportions for Peruvian guano being pound for pound, for Patagonian, one pound of gypsum for every five pounds of guano.

PLASTER, GYPSUM, SULPHATE OF LIME.

I have nothing new to offer on this subject either as regards inspection or use, and therefore place before your honorable body what I before said of it.

This substance has been most extravagantly lauded and condemned by different persons, as it chanced to act well or badly, when used by them.

The indication for its use, is its absence or deficiency in a soil.

When all of the other necessary constituents of a soil are present, this being absent, its use in very small quantities, produces an almost magical effect, making all the difference between a soil almost absolutely barren, and one very fertile. Even though it be absent or deficient, by itself it will not do any good, unless *all* of the other necessary constituents of a soil be also present, so that when gypsum does not act well on land, it may be for two reasons; the first, because of its presence already in the soil,—or secondly, because of the *absence* or deficiency of some *other necessary con-*

stituent—the analysis of the soil, or a *series* of experiments, being alone capable of deciding, to which of these causes its non-action should be attributed.

The very great difference in the gypsum which is sold in market, I shall advert to particularly when recommending some action in regard to its inspection. It is best applied by being sown broadcast on the growing crop, on clover early in the spring, and on Indian corn just before it begins to shoot. The proper quantity is from one-half to one bushel per acre. An advantage is also derived from rolling the corn in it before planting. To compost heaps, to barn-yard and to stable manure, it should be applied every few days in quantities depending on the number of stock, one gallon at a time being enough for the largest yards or stables in the country.

This should be done whether gypsum is applicable to the soil upon which the *manure* is to be used or not, as it preserves one of the valuable constituents of the manure which would be otherwise lost.

Besides furnishing the elements to crops, which enter into its composition, gypsum is decomposed by the ammonia always present in the atmosphere, which, by uniting itself to the sulphuric acid of the gypsum, loses its volatility, that is, its tendency to escape into the air.

The application of gypsum, then, besides furnishing its own elements to crops, retains for them much valuable food from the air.

This mode of the action of gypsum has been denied by some very distinguished writers, who allege against this theory, that the increase of the substances in crops which it absorbs from the air, is far beyond what the quantity applied is capable of retaining. Those who take this ground forget that when sulphate of lime is decomposed by carbonate of ammonia, the growing crop takes up the ammonia without using the sulphuric acid, which is thus left to absorb and yield to the crop successive quantities of ammonia, as long as it remains in the soil. All chemists are familiar with similar action in the manufacture of certain chemical compounds.

It is shown from analyses that some specimens contain thirty per cent. less of gypsum than others; yet he who buys, pays the same price for it, as if it contained the full amount of gypsum. The inspection should show in this, also, not only the *weight* of the barrel, but *what is in it*. When one gives $1.37 for a barrel of gypsum containing three bushels, about 46 cents per bushel, he should know how much of gypsum he is buying,—not to be forced to pay $1.37 for a barrel of something, one-third of which is only worth, at the highest rate, six cents per bushel ;—nor made

to pay for common air-slaked lime and sand, at the same rate as he pays for gypsum.

I must not be understood as charging the traders in this article with adulterating it. No such thing is necessary to my purpose. A great difference exists in the rock from which the gypsum is ground; and if there was none, still it is *possible* for it to be adulterated, and the State should take the same precaution to guard its citizens from loss from this source, as it does in other articles of which the people at large are good judges, frequently as good judges as the inspector himself. As the gypsum, (sulphate of lime,) is that which every one seeks to buy when purchasing a thing under that name, the State should so order its inspection, that each barrel should show how much of this substance was in it, so that its price might thereby be regulated. No reasonable seller should object to such regulations; and every buyer ought to insist upon them. By them, the owner of a good article would get the value of his good commodity, and he who wished to buy, would not be deceived in the purchase of that which might be of little worth. While it would deprive the seller of no right, it would give great benefits to the buyer. The seller would get the value of his article,—the buyer the worth of his money. The fact is familiar to all who use plaster, that it acts much more favorably in some years than others. This has been attributed exclusively to the seasons, but very often the difference is owing to a difference in the article used.

The smallest per cent. of gypsum in specimens which I have examined, was 51.40; the highest was 96.60 per cent., a difference of more than eighty per cent. If full one-half of that sold was of an average quality, a fair way of judging, then a large per cent. of the money spent for gypsum is thrown away.

Since my last Report I have seen frequent advertisements of dealers in this article stating that their stock had been selected by careful analyses. This being done has undoubtedly given the purchaser a better article than ever before sold. The inspection should show this to be the fact. Their great importance demands serious consideration.

I have examined many specimens of plaster during the past year, and find the average of it to be about ten per cent. better than that examined in previous years. This alone saves to the state more than *it pays* for the maintenance of the office which I hold. The stricter the scrutiny into it, the better will be the article sold.

The necessity of legislative action on the inspection of guano and plaster is sufficiently manifest from the facts which I have given.

REFUSE ANIMAL MANURE.

Under this head I design calling attention to a manure made and extensively sold in the city of Baltimore since my last Report; in consequence of suggestions contained therein, and advice which I have since given. It is made and sold by a Mr. Horner, whose advertisement may be consulted in the Baltimore papers. All attempts to supply efficient and cheap manures to farmers and others should meet with due encouragement, especially as in this case, where the manure is made from matter which has hitherto proved nuisances to the city, and now by industry and knowledge is converted into useful manure. I have examined this manure and below give its composition. It contains in a ton, of

Ammonia,	54.34	pounds.
Phosphates,	528.00	"
Plaster,	122.00	"
Salts of Potash and Soda,	114.00	"
Lime,	300.00	"

The balance being organic matter, &c., of no especial value *in a manure.* Its value, estimated by the same rule as would make Peruvian guano containing 16 per cent. of ammonia and 25 per cent. of phosphates, worth $46 per ton, is $14.44 per ton. This manure is advertised to be sold at $12 per ton, and is therefore cheaper at that rate than Peruvian guano. $46 will buy in Peruvian guano of the above standard 320 pounds of ammonia and 500 pounds of phosphates. Forty-six dollars will buy of this manure three tons and sixteen hundred and sixty-six pounds, containing of

Ammonia, 208.28 pounds—worth	$24.99
Phosphates, 20.23 pounds—worth	30.34
Total	$55.33

So this manure in point of money value will stand to Peruvian guano as $55.33 is to $46, or 20 per cent. more valuable.

As it is more bulky than guano, the freight will have to be considered, for which any one can make a proper deduction. It is also inferior to guano in the fineness of the division of its phosphates. I am fully aware of the great difficulty in fixing the exact absolute value of different substances in a compound manure, and the above estimates are to be taken only as approximations; since, however, all the values of the different manures are made by the same rule, for purposes of comparison, they will serve as sure guides.

Other manures are also manufactured in the city of Baltimore, some guaranteed to contain a particular quantity of valuable constituents, others without this guarantee. I have found the former to come up to the guarantee given, the latter, when they have been

brought to my notice, I have examined and published their con stituents, conceiving it my duty alike to show the constituents of a good article, and to expose that which is bad or sold at a price not warranted by the quantity of its constituents.

I will state here that those compound manures are not of necessity the cheaper, unless applied to soils deficient in *all* of the constituents of plants, which is very rarely the case.

FISH MANURE.

By this name is known the manure from the offal of sound fish, and those which are spoilt in the packing on our fishing shores in the tide water counties, particularly on the Potomac river. It has long been used, and though ephemeral in its effects, yet is a very quick and powerful manure. The composition of fish approaches very near to that of wheat, and we should reasonably expect for every sixty pounds applied, a bushel of wheat would be produced. This manure is nothing but guano without digestion. Experience has so fully demonstrated its value, that I need not urge its use. As hitherto used, however, nearly all of the most valuable part of this manure has been lost by being scattered broadcast on the fields, exposed to a hot sun, undergoing decomposition very rapidly with the formation of ammonia, which, having nothing to fix it, is lost in the atmosphere.

This manure contains elements capable of forming about two and a half per cent. of ammonia, and there should be mixed with it not less than fifteen pounds of gypsum to the hundred weight of the manure. The gypsum should be scattered regularly over this manure as it is put into heaps, or be immediately scattered over it when applied in its fresh state. Were this practice adopted, the value of the manure would be more than doubled.

SEA GRASS.

This too is a highly valuable manure, and one that can be extensively obtained in many places in our tide water counties. No means should be left untried to secure as much of it as possible, as it contributes a much larger quantity of valuable mineral constituents to the soil than any other kind of grass. The numerous small insects and shell fish in it, by their decomposition afford much ammonia. So highly is this manure prized in some parts of Scotland, that the right of way to the beach where it may be collected enhances the value of land from four to six dollars per acre.

Prof. Johnston, most reliable authority in agricultural chemistry, says:

"It is applied either immediately as a top-dressing, especially to grass lands—or it is previously made into a compost with earth, with lime, or with shell-sand. Thus mixed with lime, it has been

used with advantage as a top-dress for the young wheat crop; and with shell-sand, it is the general manure of the potatoe crop among the Western islanders. It may also be mixed with farm-yard manure or even with peat moss, both of which it brings into a more rapid fermentation. In some of the Western Isles, and in Jersey, it is burned to a light, more or less coaly powder, and in this form is applied successfully as a top dressing to various crops. There is no reason to doubt that the economical method is to make it into a compost with absorbent earth and lime, or to plough it in at once in the fresh state."

POTASH.

This substance in its pure state has been but little used in agriculture. It has the same influence as lime in rendering substances soluble, which may be present in the soil, but not in a form capable of being used by the plant, and in decomposing organic matter. It acts more speedily, and in much less quantities than lime, being very soluble. To soils that need it, and but very few of those which I have examined do, it should be applied in the spring. It is found very abundant in wood ashes, in the stalks, of corn, the grasses, wheat, oats, &c. These being generally consumed on the farm, and not exported, is the reason why a deficiency is so seldom found. I have not yet completed my observations in regard to this substance, as to the smallest quantity which is necessary to the acre, and therefore refrain from urging, except in a few particular instances, its application.

CHLORINE AND SODA.

I mention these substances together because when one is deficient in a soil the other is also, and so in the substance cheapest to supply either we find both; this substance is salt. It should be applied, when needed, in quantities of from two to four bushels per acre. It is most usually found deficient in soils of a loose porous texture, which are a great distance from salt-water. Besides supplying material for the straw, stalks and blades of grass, wheat and corn, it increases the weight of grain and proves destructive to many insects; it strengthens the straw and renders the wheat less liable to rust. As it can be purchased very cheap, (from fifteen to twenty cents a bushel, as a refuse from packing establishments,) it should be generally used on the wheat crop in places not adjacent to salt-water.

The above manures are those concerning which I felt it necessary to direct especial attention. I have mentioned many things which to some are already known; certainly I have introduced nothing but what all should know and understand.

In duly considering their constituents, it will be seen that they

contain all of the elements found in fertile soils, and all of the constituents existing in crops that are used for the food of men or animals. They, therefore, can supply any or all deficiencies which may exist in barren soils. When applied to land they can supply all that is needful to give it productive capacity. Their several modes of action, whether by supplying directly the food of plants which may be absent or deficient in the soils; whether by placing that which may be present, but not in a form for use, in such a condition that plants can assimilate it, or by both of these modes at the same time, I have pointed out already. I have given the best mode for the application of each, and the best mode of their preparation previous to application and the most economical quantities to be used, so far as my judgment goes. The advice which I have given is founded on very mature deliberation, and where I was uncertain I have refrained from giving any decided, opinion. Taking in view the official position which I hold, and desiring to inspire all possible confidence in instructions based on scientific principles, being desirous that the confidence hitherto manifested towards the principles which I have promulged should be continued and increased, I have been careful to advise nothing but what was obtained from the highest authority, or was the result of my own careful and oft repeated observations and investigations. I therefore with confidence can urge the adoption of my advice. That there may be errors in the above I do not doubt, that there are some truths not before urged on the agricultural community of our State I am very certain; that the adoption of these in practice will prove of great benefit, experience will demonstrate, and from its verdict there can be no appeal.

The part of the State which, in the performance of the functions of my office, I have visited since my last report to your honorable body, is that political division of the State known as the

THIRD GUBERNATORIAL DISTRICT OF MARYLAND.

It lies between 38° 3′ and 39° 23′ parallels of north latitude, and is composed of the following counties: Montgomery, Howard, Anne Arundel, Prince George's, Charles, Calvert and St. Mary's.

The counties of Anne Arundel, Calvert and St. Mary's border on the Chesapeake Bay. Prince George's, Charles and St. Mary's lie between the Potomac and Patuxent rivers; the latter county also borders on the Chesapeake. Montgomery county lies between the Potomac and Patuxent, above tide-water. Howard is bounded on two sides by the Patuxent and the Patapsco rivers above tide-water; whilst Calvert county lies between the Patuxent river, below tide-water, and the Chesapeake Bay. The geographical position of these counties pre-eminently fits them to be a rich agricultural district, abundance of water-power, in some places

appropriated, furnish great resources for manufacturing purposes, whilst its contiguity to several large cities, and the facilities for the transportation alike of produce and manures, with the peculiar excellence of the soil, give it high qualifications for fruit-growing and gardening purposes.

In every part of this section we have either the Chesapeake Bay or its tributaries, navigable rivers, or facilities for the transportation of manures or produce on the Chesapeake and Ohio Canal, the Baltimore and Ohio, or the Washington Branch Rail Road. Its rivers, below tide-water, and Bay are abundantly stored with the finest wild fowl, with oysters, terrapins and fish, the Potomac river being celebrated as affording the largest herring and shad fisheries in the Union, or perhaps in the world. The particular local advantages of each county are of the highest order. No part of the United States is superior to this in its convenience to market. Alexandria, destined to be a large city, is easily approached from the counties of St. Mary's, Charles and Prince George, being immediately opposite the latter county. The city of Washington, the capitol of and one of the best markets in the Union, with Georgetown adjoining it, can be approached from St. Mary's or Charles county by means of the Potomac, whilst the counties of Montgomery and Prince George's are immediately contiguous to them. Baltimore, the great emporium of the South, lies almost surrounded on two sides by the counties of Howard and Anne Arundel, and is of very easy access to Calvert, Charles and St. Mary's, by means of the Chesapeake Bay. There is scarcely any place in this whole district that is distant ten miles from a first rate market, or from natural navigable water, Rail Roads or the Canal. There is thus every requisite that the most covetous could desire for agricultural advantages. In some parts of it large deposits of iron ore exist. In other sections abundance of lime-stone of the best quality for agricultural purposes are found. There are also some beds of good chrome ore, with granite, seneca sand-stone and marble for building purposes. Nothing is wanting but careful cultivation, industry and a knowledge of the proper employment of manures to make this among the most valuable portions of the United States. In no place can capital be better employed in the purchase of land, and no where will labor and skill meet with speedier returns or greater rewards.

The great and growing cities which lie on either side of this district must require an increasing amount of food, which can best be produced in their immediate neighborhood. The convenience of a market will enable its inhabitants to take the first advantage of every rise in produce, whilst the same favorable locality will always give them an advantage in other respects over remote

sections. In considering all the advantages of this part of our country, one may truly exclaim—

> "How has kind Heaven blessed this happy land,
> And scattered blessings with a wasteful hand!"

Let but the people of this part of the State equal their social virtues by their agricultural skill, and it will be as famous for productive capacity as it has been for the virtues of hospitality, refinement and patriotism. The glory of its future progress will equal the fame of its past history.

It was in this section of the State that the great truths of civil and religious liberty first had an actual life. The river which washes the tomb of the Father of his Country beats on the shore where first was unfettered the minds of men, where the first altar was raised to civil and religious liberty, and where truths were established which have made us

> " Great, glorious and free;

and which will eventually enlighten the whole earth.

It is something to be proud of, the history of this part of Maryland. The idea which it portrayed was manifest in Washington, and well may Maryland and Virginia be proud of the glory of its history. The world has not yet equaled it.

I regret very much that I cannot illustrate with a map, the peculiar advantages of this as well as the other districts of the State which I have visited. It would make apparent their great natural advantages, and with a concise and accurate description of the properties of the soil would not fail to attract the attention of capitalists and wealthy emigrants, wealthy not only from money, but from knowledge, industry, and intelligence. The average width of this district is about thirty-five miles, its length is about one hunded and twenty miles. When we consider that on one side it has the Chesapeake and Ohio canal to tide-water, and then the river Potomac to its extreme point, we shall see how well it is provided with means of transportation on one side. On the other side it has the Baltimore and Ohio Rail Road to tide-water, and then the Chesapeake bay to the Potomac river for its boundary, there is then, every facility for transportation on this side. These boundaries include the whole district, save a very short line.

If, then, there were no other means of transportation, this would be sufficient, but it has not to depend only on these. The Baltimore and Washington Rail Road runs through this district. The Patuxent river divides the counties of Calvert and Anne Arundel on one side, from St. Mary's, Charles, and Prince George's on the other, and affords every facility for transportation to those counties where they are not otherwise provided

for. In Charles and St. Mary's we have several bays, (arms of the Potomac river,) extending sometimes half way through the country, navigable for vessels of the largest size. The Patuxent river, also navigable for our largest bay craft and steamboats, empties into the Chesapeake about twenty miles from Point Lookout, the southern extremity of St. Mary's county, giving to this county, Charles and Prince George's on the one side, to Calvert and a part of Anne Arundel on the other side, navigation almost to every man's door. This latter county borders on the Chesapeake on the one side, the Baltimore and Washington Rail Road on the other, whilst the Annapolis and Elk Ridge Rail-road traverses it nearly through its centre. Besides this, South, Severn, and Magotty rivers, not true rivers, but arms of the bay, distant from each other in their greatest distance about ten miles, run up into this county, giving great facilities for navigation, furnishing abundance of shell-fish, &c., and great resources for manures. Prince George's county is sufficiently supplied by the Potomac river on one side, by the Patuxent on another, by the Baltimore and Washington Rail-road, which passes through it, with whatever conveniences these can afford. Montgomery county lies within a few miles of B. & W. Rail-road on one side to B. & O. Rail-road on another, and to the Chesapeake and Ohio Canal on a third side. Howard county borders on the B. & O. R. R., on one side, and on the Baltimore and Washington Rail-road on another side. The Patapsco river, which forms its boundary on the east, is famous for furnishing magnificent water power. Ellicott's Mills, the county town through which the Rail-road passes, has in it many large flour mills, cotton factories, &c. Annapolis, the Capital of the State, is beautifully situated on the Severn near the Chesapeake Bay. The United States Naval Academy is located here.

There are in this section of the State many large and flourishing schools, academies and colleges, giving the best means of instruction to its youth, almost by their very fire-sides. The whole country is well wooded, well watered, and as healthy generally as any section of the Union.

This has never been questioned so far as the two upper counties are concerned. That part of the State on tide-water has borne an unfavorable reputation in this respect, a reputation I am sure it does not deserve, and which will become less and less true as the country is better worked, and more attention paid to hygienic rules for preserving its health. As this section at present is no more unhealthy than other sections, its reputation is due to causes to which I need not advert here.

A residence here during my whole life—a large medical practice—particular attention to the subject, and the highest professional authority, *all* concur to prove that with proper care and at-

tention, the health of this country can be made to equal any other part of this union. The diseases most prevalent are remittent and intermitting fever, in the autum. These have been attributed to the decay of vegetable matter in peculiar localities, and there are particular locations in almost every country where fevers are engendered from this cause. There is no doubt that on all of our tidal rivers and fresh water streams in the southern and western country general causes of these fevers exist, and that persons resident there are liable to them. My own very careful observation, however, has convinced me thoroughly, that this *general cause* is insufficient unless there be also *local special causes* to assist it.

If the general cause was sufficient, the whole district of country being exposed to the same causes would experience the same effects. This we all know is not the case; sometimes a particular house will suffer very much, and all others in the neighborhood will escape. In another season, a different house will be attacked, the other remaining healthy. I have frequently seen two houses within a hundred yards of each other, the one entirely healthy throughout the season, the other having its inmates frequently attacked. Sometimes a particular house will escape for several years, and then be severely visited again, alternating thus between perfect exemption from, and continual attacks to, the autumnal fevers.

All these facts, familiar to all who live in these districts, show most conclusively that a local and special cause must act with a general one to produce disease. Does not this fact at once teach us how to avoid disease, by removing its causes? How to preserve health by removing the local causes which produce disease? Remove the local cause and the general one is harmless. On this account, then, the most perfect cleanliness should be observed, and all dwelling houses, negro quarters and all other places contiguous to residences should receive particular attention. No filth, no garbage of any kind should be suffered to remain near dwelling houses, no cabbage leaves or stalks, no cucumber or melon rinds, no refuse from the wash; especially no pig-pens should be suffered to remain for a moment within a hundred yards at least of dwelling houses. I have frequently seen most violent cases of remittent fevers, dysenteries, &c., produced from these causes; first one and then another of a family would be taken down, and be benefited but slightly by the usual remedies until these nuisances were removed, when remedies would at once resume their wonted efficacy, and no more cases occur. These have not been isolated instances—their occurrence has been frequent in different parts of the State which I have visited. Neither should weeds be suffered to grow near the dwelling; cut them down and carry them with offal of every kind to the manure pit. Manure will thus be saved, means for agricultural improve-

ment provided, with strength to procure and health to enjoy its products. That this will be the result, if the advice which I have given be followed, I am convinced from my experience on this subject for several years in one particular location, from observations through several years in different sections of the State, and from the concurrent testimony of all who have a right to give testimony on this subject. Follow the history of any pestilence, from that of Athens, described by Thucydides, 400 years B. C., to the last visitation of the Cholera in Baltimore, by Dr. T. H. Buckler, and it will be found fatal just as the places in its march have been kept clean or otherwise. Proper attention to rules of health, either in a community or in the individual, cannot be violated with impunity. If due precaution be not taken by each, the penalty of sickness and death will be the consequence. The past bears strong confirmation of this fact, let the present gather wisdom from its testimony.

The locality of this section, if proper care be taken, would render it not only one of the healthiest, but the most convenient and agreeable for the residence of a large population.

The counties of Anne Arundel, Calvert, Charles and St. Mary's afford locations in many places equal in point of health, and very far superior as to beauty of scenery, to many of our fashionable watering places. The air, cooled by the winds from the Bay and Potomac, diminishes very much the heat of summer, and checks in a great degree the coldness of the winter months. It thus renders vegetation much earlier, and gives a great advantage in supplying the markets with early vegetables and fruits. No where does fruit grow to a greater degree of perfection; Apples, Pears, Peaches, Strawberries, Plums, Cherries, and indeed all that can grow in this latitude, arrive at their highest point of development. All that they require to attain this is careful cultivation. I have seen on a gentleman's* table better fruit of every kind on ordinary occasions than that exhibited for premiums at the great convention of fruit growers from all parts of the North, parts of the West and Canada, held in Syracuse in 1849. The face of the country is waving and gently rolling, no where becoming abrupt or broken. No where does the surface of a country show such a pleasant alternation of gently swelling hills and pleasant dales.

There is nothing but a series of beautiful inland views or most charming water prospects. The scenery on the Patuxent and Potomac rivers is not surpassed for beauty and elegance in any part of the globe. Either viewing the water prospects from the land, or the land from the water, a most vivid imagination is required to add or take away one point without disturbing the

* Dr. B. of Prince George's county.

beauty of the view. The scenery in some parts of Howard and Montgomery, on the Potomac, Chesapeake and Patuxent, the valley of Hanson's Branch and of Piscatawa, in Prince George's county, and that of Port Tobacco, in Charles, equal in reality all that the imagination of poets has described, or the fancy of painters sketched. I shall for a long time remember them, but am not adequate to the task of their faithful description.

In most countries facilities for navigation are attended with some counterbalancing disadvantages, to the surface of the country, but such is not the case here. The Chesapeake Bay, the Patuxent and Potomac rivers contribute no less to the beauty of the country than they do to its economical advantage.

An officer who, during the war of 1812, came with the British army up the Patuxent, informed me that its scenery was the universal admiration of all the officers of the expedition, and by common consent was pronounced equal to any and superior to most they had ever seen. This testimony from men of education, who had visited every section of the globe, is good proof of what I have stated in relation to it.

Oh, great Potomac! You banks of shade,
You mighty scenes, in Nature's morning made;
While still in rich magnificence of prime,
She poured her wonders lavishly sublime,—
Nor yet had learned to stoop with humbler care,
From grand to soft, from wonderful to fair;
* * * * Your towering hills—your boundless floods,
Your rich savannas, and majestic woods,
Where bards should meditate, and heroes rove,
And woman charm, and man deserve her love,

Are no less pleasant to the eye than useful for the purposes of domestic trade and foreign commerce. The foregoing may seem out of place here, but the beauty of a country offers as many inducements for investment of capital and labor in it, as its mere pecuniary advantages, and I should not have done justice to this part of the State had I failed to give its physical aspects.

THE SOIL.

By this is understood that portion of the earth's surface which can be cultivated so as to produce food for its inhabitants. The constituents of the soil are the same as those of plants, i. e., it always contains organic matter, and must contain all of the mineral constituents of plants enumerated in a previous section. But this is not sufficient, it must not be too wet, and must have the physical texture to enable it to absorb matter from the atmosphere. Before going into a particular description of the soils of this part of the State, I will give the analyses of several soils of notorious fertility, in order to show what the *best* soils are.

Soil from the banks of the Nile, above Cairo, producing about fifty bushels of wheat annually.

Organic matter,	13.10	per cent.
Silica, (sand.)	69.15	"
Iron, as peroxide and alumina,	13.75	"
Lime, estimated as quick lime, equal to 2.00 of air slaked lime,	1.12	"
Magnesia, (pure calcined,)	1.02	"
Potash,	50	"
Soda,	35	"
Chlorine,	20	"
Sulphuric acid,	16	"
Phosphoric acid,	21	"
	99.56	per cent.

I am indebted for the above sample to the Rev. Mr. Jones, Chaplain to the Naval Acádemy, Annapolis, Md.

This soil, though containing so large a proportion of vegetable (organic) matter, yet, nevertheless, from its large per centage of clay and fine sand, had great tenacity, and was a soil of very fine absorbent capacity. It bore a strong resemblance to some of our very best white oak soils. The lime in it existed partially as carbonate, as silicate and sulphate, perhaps also as phosphate. Had each of these been estimated in the condition in which they existed, the one hundred parts would have appeared. The soil was digested in muriatic acid and water, according to the plan usually followed, from the filtrate of the iron and alumina, the lime was precipitated as oxalate, this was converted into carbonate by burning, from which the quantity of oxide of calcium, pure quick lime, was calculated.

One hundred grains of this soil, after being burnt to destroy all of the organic matter, contained of fine sand 71.30, and of coarse sand 28.70 grains. Any one familiar with the analysis of soils would at once pronounce this to be a most productive soil. The above analysis was made with great care and caution, and is the most thorough and complete of any that I have seen published of the famous Nile soil. It is the very soil to which one would naturally go in time of famine to procure wheat, as did the sons of Jacob. In one of the volumes of Silliman's Journal there is an analysis of the mud of the Nile, by M. Laissaigne, which the editor says is " more recent and complete than that given by Lieut. Newbold, from Regnault." It is as follows:

Silica	42.50	per cent.
Alumina	24.25	"
Magnesia	1.05	"
Peroxide of iron	13.65	"

Carbonate of lime, equal to 2.05 of quick lime,	3.85	per cent.
Carbonate of magnesia, equal to .58 of pure calcined magnesia	1.20	"
Humic acid	2.80	"
Water	10 70	"
	100.00	

Though this is spoken of as being more complete and thorough than that of Regnault, yet it is evident that it is far from being complete. No potash or soda, phosphoric or sulphuric acid, or chlorine is given, though the mud must have contained, and did, all of these. It is not stated from what part of the Nile the mud was taken. This may be taken as the type of a good wheat soil, all the inorganic constituents in large quantities, with the requisite physical condition to absorb all of the organic matter from the atmosphere.

In striking contrast with this was the analysis, very partial however, of a specimen from Sahara, the great desert in Africa, for which I was also indebted to the Rev. Mr. Jones. All of which was coarse sand nearly, with a trace of iron and alumina, as silicate; there was the merest trace of lime, no magnesia, potash, soda, sulphuric or phosphoric acid or chlorine, and no organic matter was present. The specimen which I obtained was unfortunately too small to make a full analysis, it being only 15 grains. From its appearance; as well as from the analysis, one might know that it was a place "where no verdure quickens, no solitary tree takes root."

Soil from Missouri producing twenty barrels of corn to the acre, worked every year for the last fifteen years:

Organic matter,	11.00
Silica,	84.30
Iron as peroxide,	.80
Alumina,	1.10
Iron and alumina as phosphates,	.30
Lime as carb.,	1.13
Magnesia,	.30
Potash and soda	.90
Sulphuric acid,	.12
Chlorine, a trace,	.04
	99.99
Loss,	.01

Of the sand, there was of

Fine sand,	68.70
Coarse sand,	15.60

Soil of very rich bottom land in Illinois:

Organic (vegetable) matter,	9.10
Silica, (sand,)	75.00
Iron as peroxide,	5.15

Alumina, (pure clay,)	4.80
Lime (as quick lime,)	1.70
Magnesia, (calcined,)	1.82
Potash	.90
Soda	.54
Phosphoric acid,	.31
Sulphuric acid,	.12
Chlorine,	.13
	99.57

This soil had been cultivated every year for the last ten years in corn, and its estimated produce was about twenty barrels per acre.

I propose now to give the analyses of several soils of notorious fertility in our own State, from which it will be seen that, although in many constituents they are very far behind that from Illinois, Missouri, and that from the Nile, yet they are very productive.

* Soil from Col. Capron, on Balto. and Washington Railroad, Prince George's county.

FIELD No. 10.

	Improved.
Silica, (sand) coarse,	22.20
Silica, fine,	73.20
Silica, (soluble,)	.08
Alumina,	1.45
Iron as peroxide,	2 51
Iron and alumina as phosphate, trace	
Lime as carbonate,	.35
Magnesia,	.11
Potash and Soda,	.09

No. 12.

	Imp.
Silica, coarse, (sand,)	49.34
Silica, fine,	43.70
Alumina,	2.50
Iron as peroxide,	3.50
Phos. al. et ferri,	.10
Lime as carbonate, (slaked lime,)	.25
Magnesia,	.26
Potash and soda,	.15

The vegetable (organic matter) was as follows: No. 10 improved 6.80—No. 12 improved 5.15.

N. B.—In the above analyses the specimen was first deprived of organic matter.

* These soils had just produced about 38 bushels of wheat per acre.

Soil from the Potomac Bottom, near the mouth of Seneca river, being from the finest portion of what are known as the "sugar lands."

Organic (vegetable) matter,	11.50
Sand,	78.10
Iron as peroxide,	4.85
Alumina,	3.26
Lime, as quick lime,	.60
Magnesia, (calcined,)	.62
Potash,	.31
Soda,	.16
Sulphuric acid,	.10
Chlorine,	.09
Phosphoric acid,	.29
	99.88

This is a soil of very great fertility, capable of producing and does produce in a favorable year, fifty bushels of wheat per acre.

Rich virgin soil from near Davidsonville, Anne Arundel county, Md.

Organic matter,	10.00
Sand,	82.80
Iron as peroxide,	3.80
Alumina,	2.60
Iron and alumina as phosphates,	.19
Lime as carbonate,	.60
Magnesia,	.28
Potash,	.32
Soda,	.26
Sulphuric acid,	.06
Chlorine,	.04

This soil would produce at least twenty barrels of corn to the acre, and forty bushels of wheat.

Soil from Prince George's county, near Marlboro'.

Organic matter,	8.50
Silica, sand,	83 00
Iron as peroxide,	4.10
Alumina,	2.80
Lime as carbonate,	.65
Magnesia,	.21
Potash,	.34
Soda,	.12
Chlorine,	.06
Sulphuric acid,	.05

This land produces about thirty-five bushels of wheat and about fifteen to twenty barrels of corn.

These soils are very different in the quantity of their constituents, but their productive capacity does not differ in the same ratio, which shows that beyond a certain point all constituents are valueless, at least for present purposes; and that a comparatively small proportion of valuable constituents will suffice to produce a large crop, provided they be in an *active*, (that is in a condition fit to be taken up by the plant, and not in a *dormant*,) that is, in a state so insoluble that the crop cannot use them. This is confirmation of what I stated on page 29, that the *form* in which substances existed in the soil was almost of as much consequence as their actual presence. There are indeed many conditions upon which the productive capacity of soils depends. Nothing happens unless as a consequence of many causes; that one cause and one alone produces the effects which we see daily occurring is an erroneous idea. Many causes always do exist to produce the effects which we daily see around us. This is true, whether in relation to the material universe or in relation to those acts which are emanations from the human mind, and which re-act upon it. Nothing occurs without a variety of causes—the separate influence of each cause must be understood before we can know the origin of the effect; their nature, the full force of each, how they co-operate, how they antagonize, are all so many problems essential to their full understanding, essential to the ability to reproduce, to change or modify their reproduction. In manures we have no specifics, no panacea, nothing that will always act well. In soils then we must look to all the causes which produce fertility, to the composition of the soil, as to its chemical constituents, to its physical conditions, as to the solubility of their several constituents, to its location, as effecting the quantity of water which may remain upon it, and to the influence which atmospheric phenomena, rain, sun, &c., may exert upon it.

DIFFERENT SOILS OF THE THIRD GUBERNATORIAL DISTRICT, WITH DIRECTIONS TO SUPPLY THEIR DEFICIENCIES.

I shall not attempt here to give a precise description of each and every variety of the soil which occurs in this country; were I to say that each particular variety had been examined with a sufficient degree of minuteness to show the best mode of its cultivation and improvement, I ought either to be deemed incompetent to my duties or ignorant of their proper mode of performance. In plain language, I should have been either a knave or a fool. I describe those which comprise a large part of the district, which can be well known and recognized from their description, and which extend continuously over large sections of country.

I am aware of a difficulty which presents itself in naming soils not before named, but as a definition is only a short description,

I shall designate them either by terms which they have borne, or by properties which will enable all interested to recognize them. The upper portion of this district is composed mainly of

RED CLAY SOILS,

Formed from the shales which abound in it. These shales are imperfect, half-formed slates, which by their gradual degradation have formed, in a great measure, the soils adjacent to them.

These soils are compact, hard, firm, tenacious, retentive of moisture, and of a red color. They are true clays, silicate of iron and alumina, and they contain, also, some potash, soda, and other elements of plants, but not in a soluble form or condition. They are stiff, hard and compact—to improve them and all other soils we must set free their valuable matter, if present, and add whatever constituents may be deficient. These soils contain enough of potash and soda, have a fine physical condition, enabling them to absorb materials from the atmosphere; but are partially deficient in lime and magnesia, the latter of those substances in them is dormant. These soils should be in the first place drained, where that may be necessary; but this is not enough, their physical texture must be attended to, they must be made more porous, light, and accessible to atmospheric influence, they must have their deficiencies supplied; to attain the former, they should be freely supplied with the necessary organic matter. This will make them lighter and at the same time afford, by its decomposition, carbonic acid to dissolve the dormant materials in the soil.

But it is not enough to set free substances which may exist in a soil, unless they be all which are required. If there be deficiencies, these deficiencies must be supplied, more especially where their presence will not only supply what is wanting, but also render soluble that which is present, but not in a form capable of assimilation. In these soils there is an absence of lime and magnesia, not only this, but substances which, when insoluble and are practically absent, can be made soluble by the use of lime, and thus be practically present; there is then a double inducement for the application of lime on these soils, one is its absence, another the *practical* absence of substances which it can render soluble, and thus make present.

I have said that these soils, when compact, should have vegetable matter mixed with them in order to render them more light and porous, and more accessible to atmospheric influence, and that vegetable matter, by its decomposition, afforded a solvent for the elimination of dormant substances from the soil. But in order to obtain this vegetable matter, we must have all of the necessary inorganic matter, for before it there was no tree, plant or blade of grass on the earth. All of the mineral constituents were fully

made, not only made by Him whose word was creation, but made in a form conducive of and prior to vegetable life.

We read that God said, "let the dry land appear;" this was inorganic, or mineral matter, and after that, God said, "let the earth (inorganic matter) bring forth grass, the herb yielding seed, and the fruit tree yielding fruit after his kind, whose seed is in itself, upon the earth; and God saw that it was good." Here organic matter plainly follows, as the result indeed of inorganic matter.

We then must bear this in mind, that to procure organic, we must first supply the inorganic matter, and that on these and all soils, to obtain vegetable matter, we must first supply all the materials necessary to form the structures of organic life. We then should add to these soils lime, magnesian lime if possible, but if that cannot be procured, apply to them *unslaked lime*, without the magnesia; it will supply a deficiency, disintegrate the soil and cause the growth of organic matter, which will aid this process very materially. Here I will make a remark of general application for the purpose of correcting an erroneous opinion which I find still to be very prevalent, and which will continue to exist as long as those who pretend to teach the science of agriculture are themselves ignorant of it, and also without experimental knowledge. It is, that lime only acts in decomposing the vegetable matter of a soil, and in no other way. Now since lime is necessary to the existence of vegetable matter, is it not apparent that this view is incorrect? Before vegetable matter was lime existed, and to say that we must have vegetable matter before we apply lime, is to say that which is impossible of performance. It is to say that we must have the creature before the creator. If lime and all the other necessary constituents be present in *proper* form, as to solubility, physical qualities, &c., abundant vegetable matter will always be produced, so that lime is necessary to the production of vegetable matter, and does not depend upon its presence to produce beneficial effects. Lime must precede the existence of organic life, and should be applied to produce it, when absent, and not on account of its presence. I have considered it necessary to make this explanation here, because of a query just made to me by a resident on this very kind of soil, who is a very intelligent gentleman, as to whether he should apply lime until he had procured a coating of vegetable matter; he believing, as he had been taught, that lime was useless without the presence of vegetable matter, and on this account had been omitting to apply lime until he could obtain something upon which it might act. This shows how important it is to have correct notions of things generally diffused in relation to agriculture, how necessary it is to establish true theories; for without them, general true practices cannot be followed. When true, they serve to cause correct action and greatly benefit all those who apply them.

Experiment without true theory will do something, will be of benefit to him and to him alone who makes it; but when a false theory is propagated and men act upon it, they must suffer loss, they have not experiment, uncertain as it is, to guide them; they are led into false action by following rules given upon false notions of the nature of things, which must ever produce uncertainty, dissatisfaction and loss—loss which is double, being both from the doing of that which is wrong, and the not doing of that which is right.

There is a proportion of phosphoric acid in these soils quite sufficient for present purposes if it was in an active state; this is not the case, and therefore bones would be a good application, in the manner and form I have recommended when speaking of them.

The best modes to bring those soils into profitable cultivation at once, would be to give the wheat crop a dressing of Peruvian guano with a small quantity of dissolved bones, say two and a half bushels per acre. This wheat crop should be followed by clover, which should be only partially grazed; this, then, should be flushed up in the fall and lime applied. I have no doubt that the increase of current crops would pay all the expenses of the manures with the cost of labor in applying them, and after the application of the lime, would produce very fine wheat crops for a long series of years. The increase of the money value of the land would be more than one hundred per cent. in five years.

This soil from the west commences near Poolesville in Montgomery, passes through the upper part of that county parallel to Parr's Ridge, and thence passes over the Patuxent river, forming nearly all of the soils of the upper parts of Montgomery and Howard counties. It sometimes varies in color and productiveness, the former owing to a larger quantity of peroxide of iron, the latter being due to the more thorough degradation of the soil. It is intersected with many fine streams of water, is convenient to market, and can be had at very cheap rates.

The following are some of the analyses made of this soil:

Specimen from near Poolesville in Montgomery county.

Organic matter,..................................	3.25
Silica, (sand,)......................................	87.60
Iron and alumina,................................	8.40
Iron and alumina as phosphates,................	.06
Lime as carb......................................	.12
Magnesia,..	.11
Potash and soda,.................................	.28
Chlorine,..	.04
Sulphuric acid,....................................	.02

Specimen from near Clopper's Mill, on the Seneca, in Montgomery county.

Organic matter,	6.10
Silica, (sand.)	84.00
Iron as peroxide and alumina,	8.80
Iron and alumina, as phosphates,	.07
Lime as carb.	.19
Magnesia,	.13
Potash and soda,	.08
Chlorine,	.05
Sulphuric acid,	.03

Specimen from near Hyatt's Town, in Montgomery county.

Organic matter,	3.16
Silica, (sand,)	86.70
Iron as peroxide and alumina,	9.72
Iron and alumina as phosphates,	.04
Lime as carbonate,	.10
Magnesia, (calcined,)	.10
Potash,	.08
Soda,	.06
Chlorine,	.04
Sulphuric acid,	.01

Specimen from near Clarksville, Howard county, from Mr. J. C.

Organic matter,	3.80
Silica,	88.20
Iron as peroxide and alumina,	7.12
Iron and alumina as phosphates,	.04
Lime as carb.,	.13
Magnesia, calcined,	.10
Potash and soda,	.06
Sulphuric acid,	.02
Chlorine,	.03

Specimen from Howard District, on the Turnpike near Lisbon.

Silica,	86.30
Organic matter,	3.70
Iron as peroxide and alumina,	9.10
Iron and alumina, as phosphates,	.07
Lime as carbonate,	.16
Magnesia,	.08
Potash,	.06
Soda,	.10
Sulphuric acid, Chlorine, } Enough,	

These soils extend over a large surface of country, and differ in their color in different places, and also in their consistency. They are sometimes of a deep fawn color, then of a light brown; some-

times they are very compact, and then are somewhat loose and less stiff. Their deficiencies, however, are nearly similar, and they should receive the same treatment. In the upper part of Montgomery, above the Seneca, we have two other varieties of soils, which extend over a large part of Medley's district, in that county.

The first is the sugar lands, famous for their productive capacity; which is much more marked, near the mouth of the Seneca. It is compact, with a rich chocolate color. Crops upon it take an early start, and ripen quickly. Cropping out from the hills, we have shales nearly of the color of this, containing a large per centage of lime, irregularly distributed through them. Below these out-croppings the soil contains an abundance of lime, above them quick lime would be of benefit. When they are porous from the largeness of the particles of sand which compose them, they bring very fine, bright tobacco, and are extremely valuable.

The other variety is nearly of the same mechanical texture generally, but much lighter in color, which is due to the absence of the peroxide of iron. It is found in the neighborhood of Poolesville. It should also be treated with lime—magnesian is best for it.

In the white variety, that overlying the white sand-stone, there is a deficiency of phosphates, which are found in sufficient abundance in the "red soil," this overlying the red Seneca sandstone.

RED ISINGLASS SOILS.

There is another variety of soils distinctly marked, and extending over a large part of Montgomery and Howard counties. Their chief characteristic is the presence in them of isinglass (mica), and their reddish color, derived from the presence of peroxide of iron. They are quick lands, easy to work, stand drought well, and have a good depth of soil. Their great deficiency is lime, they contain generally a good proportion of phosphates, but in an insoluble condition. Their fertility varies very much, some being at present very rich, others very poor. Their physical characteristics are remarkably good, when improved they bring all kinds of grain, fruits, and where they are stiff enough, very fine timothy grass and wheat. They are very nearly allied to another variety—the

WHITE ISINGLASS SOILS.

These have not so much peroxide of iron and alumina as the red variety, and are of a lighter color. They differ as to chemical constitution in rarely containing a sufficiency of phosphoric acid and of chlorine. It is a very *kind* soil when improved, which is best effected by the preliminary steps which I have advised when speaking of land, poor from any cause; and then for permanent improvement, magnesian limes, with dissolved bones, should be

used. Salt should also be applied for the first few years. They both contain an abundance of potash. I have also found an abundance of phosphoric acid in the red isinglass variety of soils, which I have named. Notwithstanding this, bones act remarkably well upon them. This must be more from the lime which they supply than from their other constituent, and though they do act well, they would fall far behind lime, particularly lime containing magnesia, which would give to these soils permanent fertility and productive capacity. It would set free the necessary substance in the soils, improve their physical texture, give them the ability to absorb matter from the atmosphere, and make them very certain, even in bad seasons, to produce good crops. These soils form a very large part of the two upper counties of this district. Some of their best land is of these varieties, in a high degree of improvement.

They respond very quickly to the action of proper manures, and thus will give very speedy returns, neither do they suffer by heavy rains or severe drought. The great distinction between these two varieties of soil are the presence in fair proportions of phosphoric acid in one of them, its absence in the other.

ISINGLASS SOILS.

	RED.	WHITE.
Organic matter, - -	7.85	6.40
Sand, - - -	77.80	85.80
Iron and alumina, - -	12.80	6.70
Phosphoric acid, - -	.03	.01
Lime, as carb. - -	.16	.12
Manganese, - -	.30	.00
Magnesia, as carb. -	.25	.11
Potash, - - -	.20	.20
Soda, - - -	.15	.15
Sulphuric acid, - -	.01	.00
Chlorine, a trace,		

Specimen taken to the depth of 8 inches. It had never been manured with any mineral manure, nor with guano.

There is another variety of soils found in Prince George's county, very compact, heavy, and of a decidedly red color; they in many places approximate to fuller's earth in their physical condition. In ravines and deep cuts of the roads, the fuller's earth is very distinctly prominent. These soils vary in their texture from being very compact and retentive of moisture to a much less degree of tenacity—this is owing to two causes; the first, that of the larger proportion of coarse sand—the second to the less quantity of peroxide of iron and alumina; they in their natural unimproved condition are barren and unproductive. They, however,

have much to recommend them—their compactness gives them one good qualification for a wheat soil. The quantity of peroxide of iron in them affords the faculty of absorbing and retaining matter from the atmosphere, and they are very favorably located as to market privileges. They are gently rolling and will not suffer from superfluous moisture. Soils having all of these qualifications, should not be abandoned to waste, suffered to be cut up by gullies, and allowed to remain in commons. With the proper manures and cultivation they will amply repay those who may apply them.

Their main deficiencies are lime and potash. These soils contain a very fair proportion of phosphoric acid and of magnesia, at least such a quantity of these constituents as would render it doubtful whether they should be applied; with lime and potash, on the other hand there is no doubt, the deficiency of these is well marked, and they should be supplied, a small quantity of crude potash, say fifty pounds to the acre, should be well mixed with compost and applied in the spring. Besides this, lime should be applied by the rules which I have given when speaking of that article.

The mode of treatment of this variety of soil, and of all soils, should vary as it is more or less compact; when it is compact, green crops, should be turned under and mixed thoroughly with the soil, when the soil is not stiff, then the green crops should be suffered to remain on the surface and coarse manure should not be ploughed under. When the soils are stiff and heavy they should be flushed up early in the fall, and be exposed to the full influence of the effects of alternate freezing and thawing during the winter, this will set free many constituents which may be present, but in a dormant or inoperative condition. Buckwheat should be sown on them at the proper time, so as to be in full blossom early in the autumn, and ploughed under or suffered to remain on the surface as the soils were more or less stiff and compact, this would not only improve the physical texture of these soils in rendering them more accessible to the atmospheric influences, but would also furnish carbonic acid to the water that might fall upon them, and enable it more thoroughly to dissolve their constituents. Buckwheat furnishes a large quantity of organic matter, which, when decomposed, will afford a large supply of carbonic acid, for whose particular uses and properties I refer to the section on carbon.

These soils commence some short distance above the Washington and Baltimore Railroad in Prince George's county, pass down through the neighborhood of Vansville, are found between the forest lands and the Anacostia river for some distance below Bladensburg. They are met with in some modification also in Anne Arundel county, between Davidsonville and the light soils which border on South river. These latter soils have nearly the same appearance and other physical characteristics, but differ chemically in containing a larger quantity of potash, perhaps sufficient;

they should be cultivated in the same manner, however, and have the same manures applied with the exception of potash.

This soil is very well marked, being very miry in winter and *baking* very hard in summer; these physical defects would be ameliorated by the addition of proper manures, and by the proper cultivation, both of which I have suggested according to the best dictates of my judgment.

The following are some of the analyses made of this soil:

Specimen from near the Laurel factory, in P. G. county.

Organic matter,	2.25
Silica (sand,)	90.00
Peroxide of iron and alumina,	7.21
Iron and alumina as phosphates	.04
Lime as carb.,	.08
Magnesia, calcined,	.13
Potash and soda,	.07
Sulphuric acid,	.02
Chlorine,	.04

Specimen from near Vansville, P. G. county.

Organic matter,	3 17
Silica (sand,)	89.85
Iron as peroxide and alumina,	6.46
Iron and alumina as phosphates,	.06
Lime as carbonate,	.08
Magnesia, calcined,	.18
Potash,	.01
Soda,	.06
Sulphuric acid	.02
Chlorine,	.04

Specimen from near Davidsonville, A. A. county.

Organic matter,	3.40
Silica, sand,	87.90
Iron as peroxide and alumina,	8.05
Lime as carb.,	.10
Magnesia,	.16
Potash,	.12
Soda,	.09
Iron and alumina as phosphates,	.05
Sulphuric acid,	Enough.
Chlorine,	Enough.

SOUTH AND WEST RIVER AND FOREST OF PRINCE GEORGE'S SOILS.

I come now to another variety of soil, highly celebrated in its locality, for fertility and productiveness, for the ease with which it is cultivated, for the abundant returns which it gives for cultivation, and for the rapid and great improvement which has been made

upon it in a short time by the aid of one simple manure, and by subsequent culture. The manure alone used, save that improvidently supplied by its own resources, is plaster of Paris (gypsum), with the use in regular rotation of clover. These lands lie principally upon the ridge which divides the low flat lands of the Patuxent from those which border on the Chesapeake bay and its tributaries. They formerly were not very productive, under the old system of cultivation. By improvident culture they had become very barren and unproductive. A venerable and very intelligent minister of the Methodist church informed me that, forty years ago, the whole country embraced by these soils was as unpromising in its appearance and as unproductive in its crops as any section of the State, and afforded but a scanty support to a sparse and thinly settled population. Wheat was only sown in small patches around the dwelling houses; tobacco gave but very slight return on any save new land, and the Indian corn made was barely sufficient, even in good seasons to supply domestic wants, and that the fields not in cultivation were scantily covered by a thin coating of inferior grass. But a change has come over the face of the country, and what a change!

Most abundant fields of corn, and waving wheat, rich pastures of the finest clover, and fields of tobacco now occupy what was once almost a desert waste; calling to mind what the scene here once was, and viewing it now, one might suppose that the former state of things was produced by war's desolation, the latter by the benign influence of peace, that the first marked the path of a destroying angel, blighting all that it touched, the latter, the result of mercy's goodness poured out with a lavish hand. The improvement has been made solely by the application of gypsum, crops of red clover, and more thorough cultivation than had been before practiced. The improvement by these means was not slow and gradual, but sudden and almost instantaneous. I well remember large tracts of this land which a few years ago did not produce more than two or three barrels of corn to the acre, which has since produced from twelve to fourteen and sixteen barrels to the acre. A field near Davidsonville, which, previous to 1840, only produced about two barrels of corn to the acre, two years afterwards, produced fifteen, no other means being used but a bushel or two of plaster to the acre, as I was informed by the unquestionable authority of its present owner, Mr. S. H. D. This increase of crop was produced solely by improved culture, plaster and clover.

The manner in which those agents acted was as follows: those soils contain all of the necessary elements of crops in fair proportions, except sulphuric acid, they had not a sufficiency of the peroxide of iron and alumina, nor of fine sand to absorb organic food from the atmosphere; there was a deficiency of organic matter in the soil, and the materials which were present could not, under the above circumstances, afford nutriment to crops. The addition of

plaster of Paris (sulphate of lime) afforded the only necessary mineral constituent absent, and promoted the growth of clover, this, by its roots, straws, and fine leaves which it produced, gave an abundance of organic matter, which, by its decomposition, afforded abundance of carbonic acid to aid rain water in dissolving all the necessary mineral constituents. The sulphate of lime at the same time aided by absorbing and fixing the ammonia of the atmosphere, made up the sum of the necessary constituents and conditions to produce abundant crops. Plaster and clover, it is apparent, however, could only act in this manner upon soils which had all of the other necessary constituents; had any one been absent or deficient, it would not have produced any results. This shows how necessary it is to ascertain all of the conditions upon which the action of a manure depends; otherwise, as I have before stated, the success of a manure in one place will cause loss in another, where the same conditions do not exist as in other places where it had been successful. The success of clover and plaster here has been the cause of much loss in other places where it had been employed only because successful here.

This soil has a very large proportion of all the necessary constituents well balanced, that is, no one being in much greater quantity than the other. If plaster be sufficient and thorough cultivation adopted, they will, for a long time, remain productive. The sub-soils too partake very much of the character of the surface soils, and thus will, for a long time, furnish all the necessary constituents. There is now on these lands, from the large proportion of undecomposed organic matter in them, great tendency to the production of sheep sorrel, which frequently very much injures the clover crop. Oxalic acid found, so abundant in the sheep sorrel, is a product of partially oxidized or undecomposed organic matter. This can be destroyed by the application of magnesian limes, and it should be done. It will add greatly to the product of these lands, and give much increased weight to the grain. The increase of crops on these lands from any manure would not be equal to that on poor land, but a sufficient increase would be given to make the application which I have recommended one of the best investments for domestic capital that could be entered into. These soils all contain a large proportion of potash. In many cases the green sand can be seen mixed with the sub-soil. The green sand is not in separate beds, but mixed intimately, in many places, with the soil. The soil in the forest of Prince George's differs from those in Anne Arundel county, in being less compact, containing a smaller quantity of ammonia, and having the grains of sand in the soil somewhat larger, otherwise they are precisely similar. The soils in Prince George's bring better tobacco, but do not produce such luxuriant crops of wheat.

These soils commence in Anne Arundel county, a few miles above a line from the extreme point of tide-water, on South river to the Patuxent, extending down on the ridge, between the Patuxent river and the tributaries of the Chesapeake Bay, gradually running into the light sandy and white oak lands on the Chesapeake side, and into the level and compact soils, which form generally a narrow belt between them and the sandy lands which border on the Patuxent. They occupy this ridge, pass down into Calvert county for some distance below Smithville; they then pass over the Patuxent in a narrow belt, and are found at intervals in St. Mary's county, passing a short distance below Chaptico, and finally cease at the Wicomico river. In Prince George's county, this soil commences near Magruder's tavern, thence down the county to the sandy soils bordering on the Patuxent river, and sometimes running up to it. On the west side it is bordered by the scrubby and box oak soils, next to the Potomac. It lies in the neighborhood of Upper Marlboro', the county town of Prince George's county, going down by Nottingham, and is found bordering the river, near Aquasco Mills, (Woodville,) in the lower end of the county. This variety of soil seems to dip down and be covered by one very inferior to it, in the lower part of Prince George's and Charles counties, as we find in the valleys in these places the same generous soil. This is the case on Hanson's branch and the Piscatawa, in Prince George's, in the valley of Port Tobacco, in Charles, and indeed on all of the valleys in these two counties. This variety of soil crops out at a greater or less distance from the level flat table land, which forms a large part of the soil of parts of these counties. The part of the country which these soils embrace differs in many places, and I by no means intend the above for more than an accurate general description of them. To describe every change that takes place, and every sub-variety that occurs, would not be in place in a general report.

The following are some of the analyses made of this soil:—

Specimen from the summit level, on the road from the Governor's Bridge to the head of South river.

Organic matter, - - - -	8.50
Silica (sand), - - - -	83.30
Iron as peroxide and alumina, - -	6.80
Iron and alumina as phosphates, - -	.12
Lime as carbonate, - - - -	.35
Magnesia, - - - - -	.22
Potash, - - - - -	.23
Soda, - - - - -	.15
Chlorine, - - - - -	.09
Sulphuric acid, - - - -	.02

Specimen from near Davidsonville.

Organic matter, - - - -	9.26
Silica (sand), - - - -	81.25
Iron as peroxide and alumina, - -	8.25
Iron and alumina as phosphates, - -	.11
Lime as carbonate, - - - -	.41
Magnesia, - - - - -	.17
Potash, - - - - -	.25
Soda, - - - - -	.20
Sulphuric acid, - - - -	.01
Chlorine, - - - - -	.08

Specimen from Portland Manor.

Organic matter, - - - -	9.67
Silica, - - - - -	81.71
Iron as peroxide and alumina, - -	7.15
Iron and alumina as phosphates, - -	.13
Lime as carbonate, - - - -	.41
Magnesia, - - - - -	.22
Potash, - - - - -	.30
Soda, - - - - -	.21
Chlorine, - - - - -	.12
Sulphuric acid, - - - -	.04

Specimen from near Smithville, in Calvert county.

Organic matter, - - - -	6.50
Silica (sand), - - - -	84.80
Iron and alumina, - - - -	7.50
Lime as carbonate, - - - -	.38
Magnesia, - - - - -	.16
Potash, - - - - -	.24
Soda, - - - - - -	.15
Chlorine, - - - - -	.08
Sulphuric acid, - - - -	.06

Specimen from forest of P. G. county, near Brick Church.

Organic matter, - - - -	8.15
Silica (sand), - - - -	89.60
Iron as peroxide and alumina, - - -	5.50
Iron and alumina as phosphates, - -	.10
Lime as carbonate, - - - -	.51
Magnesia, - - - - -	.13
Potash, - - - - -	.20
Soda, - - - - -	.12
Sulphuric acid, - - - -	.04
Chlorine, - - - - -	.08

Specimen from valley of Port Tobacco, Charles county.

Organic matter, - - - -	7.00
Silica (sand), - - - - -	86.00
Iron as peroxide and alumina, - -	5.90

Iron and alumina as phosphates,	.10
Lime as carbonate,	.42
Magnesia,	.13
Potash,	.18
Soda,	.18
Chlorine,	.04
Sulphuric acid,	.04

All of the above are productive soils, growing from eight to ten barrels of corn per acre, twenty bushels of wheat, from 800 to 1000 pounds of tobacco, and very heavy crops of clover. They differ somewhat in their productive capacity, and I know of no better application to them than the magnesian limes, which I have before recommended.

TABLE LAND SOILS.

These embrace a very large part of Prince George's, Charles, and St. Mary's counties, being that section of them lying at the head of streams which empty into the Patuxent, and Potomac rivers, and not included in the description which I have given before. They occupy the flat country in Prince George's, commencing near Crawford's Mill, thence going down the county by Horse Head and T. B. They are found in Charles county, extending to the brow of the hills which overlook the water courses; they also form much of what are called the forests of St. Mary's. These soils are either very compact, close, and retentive of water, and with a yellow clay subsoil, and they are covered with the box oak, small stunted black oak, or they are loose and sandy, bearing cedar and pine. They are sterile and unproductive, have but a scant population, and though very near, yet stand out in striking contrast to the forest lands in Prince George's, the valley lands in Charles, or those in St. Mary's, which border on the Patuxent and Potomac.

The stiff variety of these soils have fine physical capacities and present great inducements in their purchase to either settlers or speculators, being very cheap, in many cases covered with wood, and being very convenient to market. They can be *easily* and *cheaply* improved, and will, in a few years, greatly increase in value.

The chief deficiency of the stiff variety is phosphoric acid and magnesian lime. If magnesia alone could be procured, it would answer a good purpose; but as that cannot be done, the magnesian lime would be the best application. To supply the present wants of the soil, when the lime is first applied, a small quantity of crude potash should be used, say

from fifty to seventy-five pounds per acre. On the light variety of these soils lime would be only needed according to the directions which I have before given. The mode of cultivation of these soils should be different as they are stiff or light—when stiff, green crops and coarse manure should be ploughed under in the autumn—when light, they should be top dressed, with coarse manures, and the grass crop suffered to remain on the surface until spring.

The following are analyses of some specimens of these soils:

Specimen from P. G. county, opposite Alexandria—specimen hard, heavy, and compact—surface soil. Dr. J. H. B.

Organic matter,	3.21
Silica, (sand, coarse,)	34.30
Silica, (sand, fine,)	58.92
Iron as peroxide and alumina,	3.90
Lime as carbonate,	.30
Magnesia,	.03
Potash,	.02
Soda,	.14
Chlorine,	.07
Sulphuric acid, a trace,	.01

The sub-soil from this specimen differed from that on the surface in containing 7.94 per cent. of iron and alumina, nearly double of the surface soil—should at any time, then, this soil require tenacity, or be "backward in crops," both can be remedied by turning up a small portion of the subsoil. The iron and clay will impart the tenacity, and at the same time, by its color and other properties, absorb a larger quantity of heat and of ammonia from the atmosphere.

Specimen from near Horse Head, in P. G. county.

Organic matter,	2.81
Silica, (sand,)	93.00
Iron and alumina,	3.60
Lime as carbonate,	.16
Magnesia,	.17
Potash,	.03
Soda,	.09
Chlorine,	.05
Phosphoric and sulphuric acid (traces,)	.01

Specimen from Bower's Old Fields, near Woodville, P. G. county.

Organic matter,	2.81
Silica, fine,	50.00
Silica, coarse,	42.80

Iron as peroxide and alumina, - -	3.80
Lime as carbonate, - - -	.15
Magnesia, - - -	.07
Potash, - - -	.05
Soda, - - -	.06
Phosphoric acid, - - -	.02
Sulphuric acid, - - -	.01
Chlorine, - - -	.13

Soil from table lands in Charles county, and numerous specimens from St. Mary's, show the same composition as to the above in reference to the practical treatment with manures; some show a deficiency in lime with enough of magnesia—some a deficiency of magnesia with enough of lime, all show a greater or less deficiency in the phosphates, and sometimes of the sulphates. This, however, involves no practical difficulty, as the best way to apply phosphates is to dissolve them in sulphuric acid, and thus both will be supplied at the same time. Let the general treatment which I have recommended for all poor lands be adopted, and the particular directions be followed, and ample remuneration in crops and increased value of the land by more than one hundred per cent. may be expected.

LIGHT SANDY HORSEMINT SOILS.

These embrace a large proportion of the 3d Gubernatorial District, and can be easily recognized by their description in connection with their locality. *They are loose, light and sandy, the sand being in large coarse grains, and of a clear glass bright color. They are covered most generally with small oak or pine, and are almost always covered with horsemint in their natural state.* Though these soils be generally unproductive, it is not more their fault, not more owing to their intrinsic condition than to the neglect which they have almost universally experienced in the application of manures, and in their course of cultivation. They have generally been cropped without manure and afterwards grazed without stint. They have had no benefit from manures, no respite from the constant demands made on them; and the same is true of many other varieties of soil in the State, a constant demand has been made upon them, to which they have generously responded without ever having received means or even being afforded *facilities* to meet those demands. These soils are not without their advantages—they bring crops early, and do not require much rain: a very heavy rain destroys the crops, if falling at a particular time, for one season. Their

great defect is in their physical texture, they cannot absorb necessary matter from the atmosphere, and the same condition prevents the solubility of necessary substances which may be present, but not in a form capable of being used by the plant.

The necessary constituents too which may be set free by atmospheric or other causes, is speedily washed out by heavy rains, the surface soil being a mere filter through which all the nutriment of crops easily percolates.

On this account these soils gain but little by long rest, for the substances which the "tooth of time" sets free are carried down by rains and borne beyond the reach of the plant. These soils then should be cultivated every alternate year, for they gain nothing by more prolonged rest.

Each enclosure should be a double field, that is, divided into two parts, upon one of which the grass should be suffered to grow while the other is in cultivation; correct rules and observation indicate this to be the best mode of cultivation of this variety of soils. The common "lady pea" should be sown in these lands broad cast about the beginning of May or June.

It will give, by its decomposition, carbonic acid to set free the valuable constituents of the soil. Their chemical deficiencies are magnesia, lime and sulphuric acid. They have enough of the chief constituent of bones and abundance of potash and soda, all valuable and costly constituents. From 25 to 30 bushels of magnesian lime should be applied at every fourth or fifth year, and plaster be sown on the corn crop just before it begins to tassel, and upon the uncultivated land early in the season. An abundant crop of woolly-head clover will be the consequence, with great consequent improvement.

This soil is found to a small extent in the southern border of Montgomery county, at the head of Severn, and on Magothy river, in the Piney woods district of Anne Arundel county, thence extending down on the banks of the Patuxent for a few miles back into the country, and may be found in Prince George's, and some parts of Charles and St. Mary's counties. Those in the upper part of Anne Arundel prove very fine for early marketing, and on this account are of value.

Specimen from near Pumphrey's mill, in Anne Arundel county.

Organic matter,	2.30
Sand,	94.70
Clay and iron as peroxide,	2.21
Iron and alumina as phosphates,	.10
Lime,	.13

Magnesia,	.06
Potash,	.18
Soda,	.12
Sulphuric acid, a trace,	
Chlorine,	.04

Specimen from near Mt. Pleasant, being in Anne Arundel county.

Organic matter,	1.60
Silica (sand),	95.70
Iron as peroxide and alumina,	2.00
Iron and alumina as phosphates	.08
Lime,	.09
Magnesia,	.06
Potash,	.16
Soda,	.09
Chlorine,	.03
Sulphuric acid,	.001

Specimen from near Charlotte Hall, St. Mary's county.

Organic matter,	1.06
Silica,	96.40
Iron as peroxide and alumina,	3.00
Iron and alumina as phosphates,	.09
Lime,	.04
Magnesia,	.05
Potash,	.12
Soda,	.05
Chlorine,	.12
Sulphuric acid, a trace,	.001

Specimen from Severn District in Anne Arundel county.

Organic matter,	2.10
Silica,	93.75
Iron and alumina,	3.80
Lime as carbonate,	.10
Magnesia,	.06
Potash and soda,	.12
Sulphuric acid (a trace)	
Chlorine,	.05

WHITE OAK OR PIPE CLAY SOIL.

This variety of soil forms a large part of some of the counties, and from its extent as well as its intrinsic value deserves especial notice.

I have examined it in various localities with great care, have obtained all the practical knowledge that I could of the best mode of manuring and cultivating it, and can, therefore, with the great-

est confidence urge the adoption of the suggestions which I shall make in relation to it.

This variety of soil is readily distinguished from all others by ITS WHITE COLOR, FIRM COMPACT TEXTURE, ITS LEVEL SURFACE, ITS GREAT RETENTIVENESS OF MOISTURE, by its softness and plasticity when wet, and by its firm and unyielding nature when dry. It is almost always in its original state, covered with white oak *timber*, from which it derives its name. Sometimes, however, pine grows abundantly on it, mixed with the white oak. The water which runs off from its surface is of a dirty white color, and even when it collects in pools, takes a long time to become clear; in other words, a long time must elapse before all the earthy matter in it, from its extreme fineness, subsides to the bottom. The *sub-soil* is most usually a *true* white clay, (silicate of alumina and protoxide of iron,) unless on the points of land running into the rivers and bay where red clay predominates. Occasionally, we find the sub-soil of a "mottled, marbled" character, being a mixture of the red and white clay in various proportions. Its chemical constituents are no less constant and marked than its physical appearance. It is distinguished by the large proportion of sand, by the small proportion of iron and clay, by the presence of magnesia in sufficient quantities, by a great deficiency of lime, which *is constant*, and by a tolerable supply of the alkalies, phosphates and sulphates. The sand in these soils is always in a finely comminuted state, feeling but slightly gritty under the fingers, and receiving minute impressions when placed in contact with any uneven surface. It is from the extreme fineness of the sand, that this soil derives its compact texture and its power of retaining moisture. It is this which makes up for what would otherwise be a deficiency in the clay and iron. These two latter substances are particularly important in soils from their power of absorbing and retaining moisture.

In the white oak soils, the fine sand is a substitute for iron and clay, absorbing, with great power, moisture, and whatever other fertilizing matter may be in the atmosphere, and retaining it until the wants of the plants require its use. The sand thus performs a vicarious action of iron and clay; it is a substitute for them in giving compactness to the soil; it is a substitute for them in absorbing moisture, and the food which plants obtain from the atmosphere.

The power of charcoal to absorb various gases is well known, a power derived exclusively from its mechanical texture, as shown by its great number of fine pores; and when we consider the fine state of division in which the sand exists in these soils, we readily see how a mass of it must present a very large surface for absorption, and how an almost infinite number of small spaces must exist between the grains of sand, giving it in a great degree the same properties as charcoal. For although this soil appears to form a

solid mass, yet no grain of it is in perfect contact with any other grain. This is most satisfactorily demonstrated by placing a small lump of it under the field of a microscope, when the interstices, the spaces between each grain, are distinctly visible. Another advantage which this land possesses, is, that it more readily yields the mineral agents which it contains, to growing plants, all bodies (other things being equal) being soluble in proportion to the fineness of their division. This is always acted on by those who wish to dissolve any substance of difficult solubility, by pulverizing it in a mortar. Now, in a soil, every grain of sand contains something of use to the plant, which can be more readily dissolved from fine, than from coarse particles. These soils are uniformly deficient in lime, but have enough of magnesia; they have potash and soda, as well as sulphates and phosphates, in fair proportion.

How does an acquaintance with their texture and composition teach us to improve them! What are the indications, and how are they to be fulfilled?

First,—These soils are level and retentive of moisture. They should then be drained THOROUGHLY with *surface* drains. No water should ever be allowed to rest on them. The fields should be ditched at least on two sides, with a wide deep ditch, into which a number of small surface drains should run, and one or two large drains through a field are no substitute for a large number of smaller drains. These latter are more effectual and more easily made. A plough run once or twice into the same furrow, aided by the hoe, will in most cases make a very effectual drain. The manure from the bottom of these ditches will, in a few years, pay for them if they had no other use.

These soils are compact, and, therefore, do not require a great depth of soil in order to give firmness and stability to the roots of plants growing on them. They, also, very effectively retain moisture, thus affording it to crops in a dry season; when overlying a *white* sub-soil, they can gain nothing of use from it, for these sub-soils contain almost nothing that is useful to vegetation, and some things in a condition that are injurious. How, then, should they be cultivated? Notwithstanding it is so fashionable to advocate deep ploughing; notwithstanding it is always insisted on by agricultural writers, speakers, and essayists, yet I must advise all to beware of it, on these lands, unless they have a red clay sub-soil. The only rational rules for ploughing, are short and plain. They are, to turn up a sufficient depth of soil to give a firm support to the plant, enough to retain moisture for its use, and never to go deeper, when those ends are obtained, unless the sub-soil be better than the surface soil. If it be worse, you injure, and cannot improve by deep ploughing.

If the sub-soil be better, then, and then only can you gain by deep ploughing. Reason and common sense alike tell us that, if you join a worse with a better soil, the compound will be inferior

to that better soil. If, on the other hand, the sub-soil is better than that which overlies it, then should it be turned up with the plough, because the sum of the two will be better than the surface soil.

Such being the case, you should plough shallow in these white oak soils, and never turn up the *white* clay upon which they rest. The particular depth of ploughing will vary slightly in different soils of this class, and I have never seen any that required more than five inches; most frequently three or four inches are sufficient. This depth is sufficient to support the roots of the plants, sufficient to retain enough of moisture, and there is inferior soil underneath, which would deteriorate the quality of the surface soils.

Where there exists a sub-soil of mottled or marble clay, the same rules are to be observed as regards the depth of tillage. Upon the red or yellow clay sub-soils the practice should be different, as these may with advantage be turned up, never more, however, than one inch for each rotation, which may be repeated until the depth of tillage reaches to six or eight inches. These rules are founded on the nature of the sub-soil, and its influence on vegetation.

The iron in the red and yellow clays is in the state of peroxide, that is, it is in its highest degree of rust, and can receive no more oxygen. Iron, in this condition, absorbs ammonia, (a very fertilizing constituent of the atmosphere,) and retains it until required by the growing plant. But the advantage does not stop here. The color of soils has an important influence on their productiveness. Those which are dark colored, absorb and retain heat better than those of a lighter hue. Seed, in the former, sprout quicker, and plants grow more rapidly than in the latter. So by mixing a red or yellow clay with these white soils, you will cause the crop to take an earlier start, to grow more rapidly and arrive at maturity sooner, than if a contrary practice was adopted. These clays, too, uniformly contain some lime, in which the surface soils are deficient.

We come now to speak of the best means of improving the soils under consideration, by manures, that is, by the addition of those substances in which they are deficient: deficiency or absence being always the test of manure. However valuable any thing may be in itself, it is no manure when applied where it already exists in proper form, and in sufficient quantities. From what has been said of the composition of these soils, the rationale of their improvement is plain, cheap and certain. They are only deficient in lime: Then it should be applied to them in the purest form,—oyster shell lime is the lime for these soils, because, in reference to them, it contains less impurities than any other kind of lime. If Wrightsville, New York, or Schuylkill lime, be applied, much less of manure for the same amount of money and labor is given to the soil, than if oyster shell lime be used.

Each of these limes contains a large per centage of magnesia, and more sand, clay, and iron, than that from oyster shells. As these soils contain enough of magnesia, all the magnesia applied to them is so much lost in money and labor, to say nothing of the loss of the crop which a pure lime would have produced.

It matters not in what form the lime be applied, as it is a mere question of cost, whether pure oyster shell lime, the marl, or the mould from Indian shell banks be used: all these act by supplying lime, the prime deficiency of the soil; they will act and bring it to a high degree of fertility, producing abundant crops of every kind, and the finest, heaviest crops of wheat; for these soils, from their texture, are peculiarly adapted to this grain.

The manner of applying lime to these lands now requires some notice. If it be applied to the surface a long time before the crop is to be planted, the rain, instead of carrying the particles of lime *down* into the soil, will carry them *off* from it, and in this way a large part will be lost. In loose, porous soils this surface application will sometimes answer very well; but hard, compact soils should be first ploughed up, and then have the lime scattered immediately on the surface. In this way none will be lost.

The *quantity* of lime to be applied is the next subject of consideration. Here again we have to consult fertile soils of this class. Science has given them a language, every sound of which is truth.

The most productive have not shown over two hundred bushels of air-slaked lime to the acre, to the depth of twelve inches. There is no need then of ever giving them more than this quantity. Six or seven-tenths of one per cent. is always enough. Up to this point, the larger the quantity the better will be the crops. All who have this variety of soil should apply lime to it. If it be impossible to apply a hundred bushels, apply fifty; if not fifty, then twenty-five; if not twenty-five, then ten bushels, and do it at once;—make a beginning, however small, and its good results will soon persuade all to make the effort, to surmount whatever trifling difficulties may intervene, and lead them to apply the necessary quantity.

Besides lime, a slight dressing of compost manure, made from the scrapings of the woods, will greatly aid in the improvement of these lands. It will materially quicken the action of the lime. I need not give the reasons, the fact is certain and quite sufficient for our present purpose.

The best mode to improve these soils and get a speedy return, is to apply lime to the corn crop. Plough up the field in the fall, apply lime immediately, and plant corn in the

spring. The cultivation of corn will thoroughly mix the lime with the soil. Peruvian guano should then be applied, say from 150 to 200 pounds per acre, and the wheat sown, to be followed by the clover. This last manuring will, for a long time, bring good crops of wheat and also of corn; of the former, as productive as some of those lands now selling for five or six times as much as the unimproved white oak land. That part of Anne Arundel county known as the Swamp, if the above directions were followed, could be made as productive as the best West river land. Its superior facilities for market would give it an advantage over it.

On Kent Island, in Talbot and Dorchester counties, immediately opposite to the Swamp, some of the most productive lands in the State are found. They are of this variety, and a few years ago were as unproductive as are now the Swamp lands.

There are millions of acres of land elsewhere now not worth in the market more than from five to eight dollars, which, by the application of as much moi ey in the proper manure, will pay for themselves and for the manure, by the very first, or, at most, the second crop. Lands, precisely similar to them, have produced from fifteen to twenty bushels to the acre, after proper draining and liming, which before would not produce more than four or five, frequently no more than two or three. I know many examples of this kind, upon which all may depend, which prove these two prime facts :—1st. That these lands, when improved, are the most productive and valuable in our State, taking every thing into consideration ;—2d. That lime is the cheapest agency to effect this improvement. I need not say that in their unimproved condition they are the least profitable of all of our varieties of soil. If there be any one kind of manure which I can recommend for any particular soil with more confidence than any other, it is

PURE LIME TO WHITE OAK SOILS.

If this cannot be obtained, then the Potomac or Baltimore limes should be used. I have never known one single instance of failure from the use of oyster shell lime on these soils, where proper cultivation was also followed. The most productive lands in some parts of the State are of this kind, and made so by the use of this substance, and manure from the common resources of the farm. Land there, which twenty years ago was considered dear at ten, will now readily bring fifty and sixty dollars. The same degree of improvement has occurred in many other of the counties of this shore, but not so generally

as in Talbot. I have now given the nature of the composition, and best means of improving this variety of soil; shown what indications Analytical Chemistry declares were to be fulfilled to render them fertile; and I have shown that where these indications had been carried out, they had never failed to produce the desired result; that art and science, theory and practice, all pointed to the same system of cultivation, and the same kind of manures. It remains then for the owners of this land to act their part, and their labor should be the less irksome from the certainty of its success.

The following are a few of the many analyses made of these soils:—

Specimens from Severn District, Anne Arundel county.

Vegetable matter,	4.00
Silica sand,	92.10
Iron as peroxide,	1.28
Alumina, (pure clay,)	1.90
Iron and alumina as phosphates,	.09
Lime as carbonate,	.11
Magnesia,	.22
Potash and soda,	.18
Sulphuric acid and Chlorine, (enough.)	

Specimens from Swamp in Anne Arundel county.

Vegetable matter,	4.50
Silica sand,	95.80
Iron as peroxide,	2.10
Alumina, (pure clay,)	1.83
Iron and alumina as phosphates,	.10
Lime as carbonate, (air slaked,)	.14
Magnesia,	.20
Potash and Soda,	.22
Sulphuric acid and Chlorine not estimated quantitatively, but enough.	

Specimen from P. George's on the Potomac river.

Organic matter,	2.60
Silica,	94.00
Iron as peroxide and alumina,	2.50
Iron and alumina as phosphates,	.09
Lime as carbonate,	.09
Magnesia,	.26
Potash and soda,	.21
Sulphuric acid and chlorine—enough.	

There are many other varieties of soil in this division of the state, of smaller extent, which I have not particularly described. Some of these are of the very first class of soils, as on Elk Ridge, in Howard county, which has long been amongst the most pro-

ductive in the country. On the Patuxent River, in St. Mary's and Charles counties, and on the Wicomico River, there are soils differing somewhat from any that I have described, yet of great productive capacity. There are also many *sub-varieties* of soils which I have examined, and whose deficiencies have been made known by other means pointed out by the law, by lectures, conversations or *written statements*. This latter mode, *not included in the law*, I have been called on to follow to such an extent as would almost deprive me of all time for other duties.

The law as it stands seems to intend that *particular* descriptions of the soils of each county should be given to the county commissioners, and not included in a general report. I have ever been ready to discharge this part of my duty.

I do not think that it would be in place to include minute particulars in a general report, unless these minutiæ were of general application.

MARLS OF THE THIRD GUBERNATORIAL DISTRICT.

There is a great quantity of marl in the tide water counties of this district, but generally they do not possess the value of those found in the First District on the Eastern Shore. It extends, as a substratum, nearly all through them at a greater or less depth, and is found cropping out at the sides of hills, in ravines, and on the banks of rivers.

I have examined very many specimens of it that will not repay the cost of its application, some that are very fine, and I am aware that many specimens have not been submitted for examination, some of which are no doubt valuable. In all cases where I have not given to owners written statements of the analysis of their marls, it has been because their application would not have been profitable.

It would have been very pleasant for me to pronounce every specimen "first rate," could I have done so as the interpreter of chemical analysis; this I could not do, however, and their real worth was given. Men had better have an unpleasant truth told to them than be buoyed up by false hopes, and deluded by anticipations that can never be realized. The following are very good marls:

Marl from near Woodville, P. G. County. Hon. J. D. Bowling.

Silica,	52.00
Iron and Alumina,	1 80
Lime and Carbonate,	43.70
Lime as phosphate, (bone earth,)	1.50

Marl from Mr. Tolson, on Hanson's Branch:

Silica, - - - - -	65.00
Iron and alumina, - - - -	1.10
Lime as carbonate, - - -	33.30

There is a large stratum of marl extending all the way down this valley, which is easy of access, and will prove valuable to the poor lands in its vicinity. In every case marl should be applied having the largest number of shells in it. I would not advise the application of any of the so-called Jersey marls which I have met with in this Gubernatorial District, on account of their green sand constituents.

Specimen from Upper Marlboro', P. G. county:

Silica sand, - - - -	60.60
Iron and alumina, - - -	4.36
Lime as carbonate, - - -	33.25
Potash, - - - -	1.60

This marl lies high and dry, is of very easy access, and would much benefit some of the lands near it. It has, however, never been used.

Marl from Dr. B. I. Semmes, near Piscatawa:

Silica, - - - -	58.00
Iron and alumina, - - -	8.80
Lime as carbonate, - -	42.00
Potash, - - - -	1.16

Marl from the bank near Piscatawa:

Sand, - - - - - - -	58.00
Iron and alumina, - - - - -	3.25
Lime as carbonate, - - - -	38.00
Potash, - - - - - -	.60

There is an immense bed of this marl in the neighborhood, which will repay the cost of its application.

There are several very good marls which I have examined in St. Mary's county, the results of which have been forwarded to their owners. As *good* marl is of great value, any specimen that may be forwarded to me hereafter I will examine, should I have opportunity, and show its composition to its owner. Its value cannot be too highly appreciated, and the composition of every marl and limestone in the State should be known, that those which are good should be used, and all hopes of benefit from those that are worthless should be abandoned.

In presenting this, my second report, to your honorable body, I have endeavored to give all the knowledge in my

power to the agricultural community as to the composition of the soil, the best modes of cultivation and the proper manures to supply their deficiencies.

I have devoted a large share of it to the history and composition of manures in general use, and have called particular attention *to one* now holding a high rank in the estimation of the agricultural world. I conceived it to be my duty to throw all the light I could upon its composition, its treatment previous to use, and to urge, *pertinaciously* perhaps, a proper inspection of it.

I knew full well that its value and reputation would bring it more and more into use every year. I was aware that great loss had been already incurred in the purchase of an inferior article, and I knew that this would again happen unless a proper law for its inspection should be passed. Many small farmers buy small portions of it; the purity of it to them is of vast consequence. They do not strive to show by its use a large balance sheet at the end of the year, but are toiling for bread and that which they estimate of far greater account, the means to educate their children. They should know what they are buying, and receive the full value of their money. I have pointed out with strict geographical accuracy the local advantages of that part of Maryland which I have visited, believing that our State, particularly the sections which I have described, has suffered very much from general ignorance as to their peculiar unrivaled advantages.

The local and intrinsic advantages of Maryland should give her a high rank amongst her sister States, and if properly improved cannot fail to place her among the foremost in her industrial resources. In the history of the past her name stands high on that roll of fame where the lowest is immortal; but she may, and probably from her position will, have equally glorious duties to perform. A border State, as to institutions peculiar to one section of the Union, she will have to act as the bulwark of their preservation. None can doubt her patriotism to do this. She should secure to herself the ability. Let her educate her youth, improve her soils by diffusing scientific knowledge, develop all her advantages, and retain her citizens within her jurisdiction, and she will have the strong arm to carry out the purposes of her brave and patriotic heart. She can then say to fanaticism when it reaches her borders, "thus far shalt thou come and no farther; here shall thy proud waves be stayed;" and she will have the ability to enforce the command.

There are many things which I have investigated and have not included here, striving to present those things which would

prove of greatest benefit to the agricultural interest. I have devoted all of my time, all of my energy, all of my ability to the duties of my office, and with the means supplied by it, aided by some from my *private resources*, I have endeavored to carry out its spirit, and to do "the greatest good to the greatest number." The imperfections of the present law were pointed out to the House of Delegates at its last, and I shall make them the subject of a particular memorial to you at your present session, with the confident hope that due regard for the interest of the State and obedience to the general wish of the people will give such amendments to it as will most conduce to its efficacy.

I know, and all know who have information on the subject, that it is *utterly impossible* to carry out the letter of the present law, so as to make it of any benefit whatever. I, therefore, in my second, as I did in my first term of office, carried out to the best of my ability its spirit. The General Assembly sustained me in my course then, and as the reasons which caused my action then have been and are in full force now, I confidently anticipate similar results.

There are some, I know, who have taken exception to my not obeying and administering the law according to its letter, but I am sure that when they have a proper understanding of the nature of the duties to be performed they will admit the propriety of my course. At any rate I desire to have the fullest inqu'ry and investigation into all of my official acts, and *I am prepared to meet any responsibility* which I may have incurred.

I could not close this report without giving publicly my heartfelt thanks to the people at large for the kindness and generous confidence which they have on all occasions manifested to me. I do not flatter myself that this has been due to any personal merit of my own, but on that account am not the less sensible of the honors which have been conferred on me. The *cause* in which I was engaged was dearer to me than any considerations of self, and tributes of respect to it could not fail to excite the warmest feelings of thankfulness.

To all who have extended to me tokens of respect and consideration, I again repeat my sincere thanks, and give them in return all that I have to give, heart-felt wishes for their peace, prosperity and happiness.

JAMES HIGGINS.

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